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The Education of a Scientific Generalist

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THE COMPLEXITIES OF MODERN SCIENCE and modern society have created a need for *scientific generalists,* for men trained in many fields of science. To educate such men efficiently would require modified courses and new ones. However, a good beginning can be made now with courses which are available in many colleges and universities. One such program is set forth here.

General Considerations

The central problem. Scientific and technological advances have made the world we live in complex and hard to understand. We have today large scale division of labor, complex and indirect methods of production and distribution, large communities and large areas held together by common channels of transport and communication, and operation with small margins of safety, requiring close and delicate control. All these complex and delicate activities produce scientific and technological problems of great difficulty.

Science itself shows the same growing complexity. We often hear that "one man can no longer cover a broad enough field" and that "there is too much narrow specialization." And yet these complexities must be met—and resolved. At all levels, decisions must be made which involve consideration of more than a single field.

These difficulties are most pressing in the borderline fields like physical chemistry, chemical physics, biophysics, biochemistry, high polymers, and the application of chemistry, physics, and mathematics to medicine. It is here that both the challenge of the problems and the difficulties arising from over-specialization are greatest. We need a simpler, more unified approach to scientific problems, we need men who can practice science—not a particular science—in a word, we need scientific generalists.

Research teams, aggregations of men of diverse skills working on the various aspects of single problems, have been widely used and have accomplished much. Their use is certain to continue and expand. But the research team must have a leader to unify the group, whether he be director, coordinator, or advisor. This leader must work as a scientific generalist, and we feel he would function better if trained with this in mind.

There is a clear remedy for these complexities, both in education and in science, but its use will involve work and time. We must use the methods of description and model-construction which, in the individual sciences, have made the partial syntheses we call organic chemistry, sensory psychology, and cultural anthropology. We must use these methods on the sciences collectively so that, eventually, one can learn *science,* and not *sciences.*

We suggest that an attempt to unify science may reasonably start from the following ideas:

1. All science began as part of "natural philosophy" and radiated outward. (Even in this modern day, it should be possible to recapture the universalist spirit of the early natural philosophers.)

2. Scientific method is common to all sciences. (The difficulty that almost all scientists have in defining scientific method does not lessen the importance of this fact.)

3. Almost every science is more easily taught by using some of the equipment of the others. (This is generally admitted to be true for mathematics in physics, less generally for chemistry and physics in biology, to name two examples.)

4. Statistics, as the doctrine of planning experiments and observations and of interpreting data, has a common relation to all sciences.

5. Unification will be more easily attained if the logical framework of the individual sciences can be identified and isolated from their factual content.

The isolation of the logical framework of the sciences is a long overdue first step toward a synthesis of science. What is the logical framework of organic chemistry? Or equivalently, what are the characteristic ways in which a good organic chemist thinks and works? There is no place where a student can learn this directly, no place where it is set forth clearly, freed of as many detailed facts as possible. A second

step would be the development of courses within individual sciences which really make use of the material and equipment from the other sciences.

A synthesis unifying the sciences is, at best, a long and difficult task. It is a problem that will take time to solve and we do not have a facile answer to it. We shall consider ways in which potential scientific generalists might, as undergraduates, be given the kind of background that would enable them to develop into real scientific generalists. Ours is frankly only an interim proposal; it makes no real synthesis. Yet, since the student will go deeply into parts of many sciences, he will learn something of the habits of mind of the chemist, psychologist, and geologist. These habits, and not subject matter, are what distinguish the sciences—for how else can we distinguish the chemical physicist from the physical chemist, the mathematical biologist from the biomathematician!

Relation to Other Programs

Generalists and scientific generalists. By confining ourselves to scientific generalists, we do not intend to undervalue the need of true generalists, trained in all disciplines, science among them. Science should be able to look to such true generalists for considered judgment about the fields where the greatest speed of development is needed, and then to the scientific generalist for help in attaining that speed. Acting alone, scientists are not competent to plan the training of the true generalists, so that, in spite of the great need of such men, it would be inappropriate for us here to attempt to lay out a program for their training. Nonetheless, some aspects of the scientific generalist's training bear on theirs.

Liberal education. We do not believe that a satisfactory synthesis of the modern world can be achieved without incorporating within it science and the scientific method, which have had a major share in shaping that world, and are still forcing the pace of change. First, however, we must develop some satisfactory synthesis of science by itself, else how can we hope for the greater synthesis of a liberal education, in which science plays so large a part?

Moreover, it seems clear that scientific methods of description and model-building are in many ways the most efficient intellectual techniques yet devised for covering a broad field quickly. Since any satisfactory program of liberal education involves covering an immense mass of material in a limited time, the most efficient techniques must be used. We lay stress in the generalist's education upon these techniques, and in particular upon taking advantage of the efficiency to be gained by using in each science some of the equipment of other sciences. We feel that similar efficiency *could* be gained in history, philosophy, and the "nonscientific" fields by using these techniques. We are not historians or philosophers. We can only say that we think historians and philosophers who are also scientific generalists seem most likely to begin this task.

Finally, we believe that while the scientific generalist's education is not intended primarily as a general liberal education, it may be a temporary approximation to one. The program we outline has room for enough nonscientific courses to meet the going minimum standards of a liberal education as well as the program for a scientific specialist does today. A true generalist would, of course, require a much broader program. In spite of this, a college graduate with an education based upon the generalist's program might well be a better lawyer, businessman, or teacher of high school science than one with a classic liberal education or one with specialized training in a single field.

The Scientific Generalist

What is he? By a generalist—and we shall not bother to specify every time that we mean scientific generalist—we mean a man with training and a working sense in many fields of physical and biological science. His principal interests may be broad or sharply defined, but he is exceptional in his breadth of appreciation. He may be working in pure science, or in the application of science to engineering, business, or industry. He may not be as good a physicist as a student or research man who has been trained principally in physics, or as good a geneticist as the biologist who is trained in genetics, or as good an economist or engineer or psychologist as a specialist in those fields. But he has learned enough of these fields, and of the central tools of mathematics and statistics, to bring to problems of almost any kind the ideas and broad tools of any combination of these many subjects that will speed and improve the work.

We are interested here in the education of a generalist during his four undergraduate years. These four years will not complete his education, any more than four years complete the education of a chemist, a psychologist, or an economist. After these undergraduate years, the budding generalist will go on with further study, presumably in some special field. The aim of the four undergraduate years is to give him a broad foundation and to open his mind to a wide range of scientific fields. Eventually, perhaps, there will be graduate training as a generalist, but until that day comes, specialized graduate study must serve.

Who needs him? First, any research group needs a generalist, whether it is an institutional group in a university or a foundation, or an industrial group

working directly on industrial problems. If the problems are broad enough to require a group instead of a few isolated researchers, then there will be a place for a generalist. Many groups who now have generalists or near generalists do not recognize them as such, but think of them in terms of their specialties.

In addition, any first-class administrator or policy-maker in fields related to science must be a generalist to a considerable degree, if only to foresee external influences which might rock the boat. For example, the production of plastics has radically affected almost all enterprises based on the manufacture of small intricate parts. A good administrator needs a generalist's background in appraising the possible effects of going research, estimating its time of fruition, and judging the date and intensity of its ultimate impact on his organization.

What would he do? Many illustrations of the contributions a generalist can make to a research group can be drawn from the recent war. The ability to isolate critical elements, to establish the essentials of the logical framework, to reduce the problem to a few critical issues, is essential in handling problems of military engineering and operations analysis; it is also the ability that the scientist uses every day in his own work. The scientists who were able to carry over and apply their methods of thought to other fields were able to assist largely in the solution of military problems. By working as generalists these scientists distinguished themselves from the specialists, who found themselves baffled and uncomfortable when confronted with unfamiliar and ill-defined issues.

The problems of social engineering and economic engineering are similar to those of military engineering in their need for immediate action, their confusing variety of aspects, the lack of definition of their issues, and, often, the lack of basic knowledge appropriate to their solution. It seems not too much to hope that scientific generalists, amateur and professional, can do much toward developing these fields and solving many pressing problems.

In an engineering group the generalist would naturally be concerned with systems problems. These problems arise whenever parts are made into a balanced whole—balanced so as to serve an end efficiently. It may be weights that are balanced, or sizes, or complexities of component pieces of mechanism, or expense, effort, or research time applied to different phases of the problem.

In the social sciences, the generalist would provide background in physical science and in scientific inference, and experience in the analysis of data and in use of mathematical methods and techniques, which together seem essential for that rapid development of social science which we all agree is now so urgently needed. The generalist would assist in the construction, interpretation, and modification of mathematical models. He would examine previous findings from a fresh viewpoint. The generalist would be able to assist in the design of experiments—still a fairly weak spot in most of the social sciences. Incidentally, he would assist in the development of statistics by disclosing unsolved problems.

In biological and medical science he would provide efficient interpretation of data and design of experiment, and—what is most important—would suggest physical explanations or mathematical models for known or conjectured facts. The need of such useful and stimulating people is probably better recognized in this field than in any other that we know.

And finally, a student equipped with the undergraduate training of a generalist would have an ideal start toward becoming a consulting statistician, who must work with others on problems in many fields of science and technology. With this foundation, a graduate training in mathematical and theoretical statistics would produce the best beginning of a consulting statistician that we can plan today.

What is his background? Most of the small number of generalists that any institution might train during a year are, we think, going to have the following characteristics: They will be planning, definitely or tentatively, to go on to graduate study in some field. They will have interest and skill in science, fairly general and unspecialized. They will have met and mastered competition in high school (or preparatory school) and will have the self-confidence to attempt an unusual and challenging course in college. They will want to learn, and will be prepared to work hard. After a broad introduction to science, and after they have learned what the various fields of science are really like, and how the practitioners of these fields think and work, they will be able to make an intelligent choice between (1) some single field of science, (2) some borderline field between two or three sciences, and (3) the profession of being a generalist.

Educating the Generalist Now

Principles. There are certain principles that must govern any plan for educating a generalist—an interim plan using present-day courses or the efficient plan of the distant future. Some of these principles are general and will offend no one; others are specific and will bother some administrators and some scientists. Let us list three:

1. The pregeneralist must study many fields of science deeply enough to understand their logical frame-

work and the approaches of their practitioners.

2. With the possible exception of a few tool subjects, the interest of the pregeneralist in factual information is definitely secondary.

3. Skipping prerequisites is to be encouraged.

The idea of skipping prerequisites may seem strange and shocking, but the generalist as such will always be working on problems for which he has not had the normal training. He needs to learn to work well under these adverse circumstances during his college years if he is to prepare for his job realistically. Such flexibility will make administrative complications, and will produce temporary discomfort for many instructors.

Program. We now give an illustrative program, which is specific enough about individual courses to make these principles explicit:

ASSIGNMENT OF 40 SEMESTER COURSES

Biology	4	Statistics	4
Chemistry ...	4 or 5	English	2
Geology	1	Industrial processes ...	1*
Mathematics	6	Judging	1*
Physics	6	Surveying	1
Psychology	2	Distribution	8 or 7

* If these special courses are not available, the time freed is to be applied to independent work or to distribution.

SUMMER WORK

1st: Summer surveying course listed above.

2nd: Completion of the language requirement of a broad reading knowledge in two important scientific languages (if possible by foreign study this summer).

3rd: Work on a research or development project involving real engineering problems.

INDEPENDENT WORK

Junior Year: Topic involving economic considerations.

Senior Year: Topic involving at least two fields and preferably three.

This program is a definite overload, since it combines 40 semester courses with independent work. But the pregeneralist must be an unusual student, building on high precollege attainment. Any student who does not understand what he has studied will be useless as a generalist, and will have achieved a "smattering of ignorance." Since most schools allow students to limp along with low grades, the pregeneralist's standing must be a full grade higher than that required in other programs.

Besides carrying out his formal program, the pregeneralist should meet regularly with sympathetic and active graduate students and faculty members, for lunch, perhaps, or to drink beer.

The regular courses. We take first the bulk of the program, reserving the special courses in English, industrial processes, and judging for a separate discussion.

The "distribution" courses will have real value for the generalist. History, philosophy, economics, the humanities, and the social sciences come here. Some educators might emphasize the need for a course in social change and cultural lag, others would put the emphasis elsewhere. We cannot plan these distribution courses now; their planning should involve all departments, and should probably not be too rigid.

Next come the courses in various fields of science. While specific courses are stated, *it is always permissible to replace any course by a more advanced course in the same field.*

In biology, where we include paleontology, paleobotany, physiological psychology, and the like, there are to be four courses. What shall they be? We do not feel prepared to make really detailed suggestions, and can only point out that it is essential that not all of the courses be at the elementary or near elementary level. It has been suggested by one of our friends (K. W. Cooper) that if four semesters of work in biology were to be given to such students, the most desirable plan might be: (1) cellular biology or general physiology (from the viewpoint of transfer of energy, intermediary metabolism, physiology), (2) comparative anatomy (from the developmental and truly comparative point of view), (3) the problems of genetics (persistence and change of hereditary patterns), and (4) evolution and the evolutionary record. If such a program were available at any institution, we would gladly recommend it as one good set of four courses for the training of a generalist.

The four or five courses in chemistry we propose must give the future generalist a bird's-eye view of a broad field. Hence, we advocate a large amount of skipping around: one or two semester courses in elementary chemistry, one semester in organic chemistry, one semester in physical chemistry, and one semester or none in an advanced elective. To the chemist, the idea of taking one semester of organic chemistry and then jumping to one semester of physical chemistry may seem strange, wild, and unwarranted. But the student generalist wishes to learn how a chemist thinks, how problems are approached, and in what general direction he may learn things once they seem necessary or useful in a particular problem. One semester of organic chemistry (whatever classes of compounds are discussed) and one semester of physical chemistry (whatever branches are included) will do much to orient him and give him a basis on which he can build later as needed. He will know enough physics and mathematics to learn physical chemistry.

Only one course is listed in the field of geology, since paleontology, paleobotany, and the like were included under biology. Just which course is to be taken can safely be left to the choice of the student.

In mathematics there are standard courses available: four semester courses or less in elementary

mathematics through calculus and differential equations, one semester in complex variables, and one or more semesters of advanced electives. These courses seem to need little comment.

In physics (where we include astronomy) the situation is also simple, for the courses which should be taken are available at most institutions. Here we suggest: two semester courses in elementary physics, one or two semesters in electricity (circuits and waves), one semester in physical measurements, and one or two semesters of advanced electives. We feel that a knowledge of electrical circuits and the associated knowledge of the uses and behavior of electron tubes would be an essential tool for a generalist in almost all the fields that interested him. The other courses seem to us to require little explanation.

Two courses are proposed in psychology: one semester course in experimental psychology, and one in systematic psychology. Experimental psychology will include laboratory work. Systematic psychology will be a study of psychological problems and theories, with some emphasis on methodology and classic experiments. It will provide a theoretical interpretation for the experimental course. Here the essentials seem to be (1) learning how the psychologist approaches his problems, and (2) acquiring an appreciation of the complications and difficulties which the human observer always introduces into any experiment or study.

In statistics we propose four semester courses, which can probably be found at a few institutions where the training in statistics has been well organized and developed: one or two semester courses in elementary mathematical statistics, one semester in design and analysis of experiment with practical work, and one or two semesters in advanced mathematical statistics, including multivariate methods and the use of order statistics. Because statistics is one of the main tools for applying the quantitative method to any field of science, we feel that four semester courses are by no means too many. We feel that statistics is a distinct field, rather than a branch of mathematics under a new name.

English has been allotted two semester courses in composition. These should be, primarily, courses in exposition. We should prefer to have one a freshman course in "How to Say What You Mean," orally and in writing. The other should be a junior or senior course in writing technical reports, papers, and expository accounts, with emphasis on getting the results and essential spirit across to nontechnical readers.

The proposed inclusion of a course in surveying in this curriculum has led to considerable discussion, and it seems worth while to make very clear what values we hope might be obtained from it, particularly if it were taken just before the beginning of the freshman year. It would provide students with experience in physical measurements for which there are checks (the traverse must "close"), and give them opportunity to observe the customary processes of handling data. It is not essential that the student become a good surveyor, but it is very much to his advantage to learn to recognize a man who is good with tools, and good at measuring.

The special courses. There are two courses that we think should be added to present offerings in order to improve the interim training of the generalist. The first could be given tomorrow at many institutions. The other, here somewhat obscurely entitled "judging," would be very difficult for anyone to teach.

The course in industrial and shop processes should summarize how things are actually made. It could be entirely descriptive, since it is to train generalists, not engineers, and therefore one semester would suffice. It should, for example, describe forging and milling, the function of a turret lathe, the kinds of heat treating used and their effects, what an industrial still looks like, and how it operates—in other words, teach him the unit operations of mechanical, electrical, and chemical engineering. The generalist needs some knowledge of how materials are manipulated.

Somewhere in the curriculum, probably in the senior year, there should be a course in judging, guessing, and the scientific method. This course is needed not only by the generalist, but by many other scientists. We have no way now to encourage or require a man to bring his education and intelligence to bear on estimation and prediction problems for which he has inadequate information. As a result, scientists often become stuffy and narrow in their views. To meet this need, we propose a course in educated, intelligent guessing. It would be principally a laboratory course, in which essentially impossible problems were put to the student, who would be required to supply answers and estimates of their trustworthiness, on the basis of the inadequate data given plus what he knows about the world. The time limits for these answers would vary. Some problems would be done by individuals; others by groups. There would be discussion periods after solutions were submitted. The main difficulty with this course would be finding an instructor equipped to teach it.

None of these four special courses is essential to the training of a generalist, but all of them would be extremely helpful. We believe their value to other students as well as to generalists would make them worth adding to the offerings of most colleges.

Another generally useful course which we would place next in importance for the pregeneralist is one in "intellectual techniques." This should supply the student with tools which would help him to ingest and digest a large amount of material in a limited time. It should include rapid and effective reading, quick ways of using a library, and what is known about efficient methods of study and learning. Such a course should come in the freshman year if possible. Some of us feel that introductory psychology is a good facsimile, others feel that it does not concentrate enough on the tool aspect to meet the need.

Installing the program. Before any new program can be introduced into an American college or university without objection it must be shown to fill certain needs. For the next decade colleges will ask: Does this program meet the distribution requirements? Does this program fit into the scheme of departmental concentration or majoring?

Distribution requirements vary from institution to institution, and are in the process of changing at many institutions. We have compared the proposed program with the distribution requirements at Harvard and at Princeton, since we are most familiar with these universities. There the distribution requirements would easily be met. It seems reasonable to conclude that this program would be consistent with the distribution requirements of a substantial number of institutions.

Next, there must be a home for the pregeneralist. Some department must be prepared to accept his widely distributed work as concentration in that department. Or a new interdepartmental program must be set up! Fnding a home may be difficult.

There will be difficulty with individual scientific departments wherever such a program is proposed; each such department has a natural desire to have these very good students concentrate in its department.

Finally, there will be objections from administrators about any program requiring students to take courses without the usual prerequisites.

These difficulties of installation, however, are merely details, and such a program can be started.

The point of view we have tried to expound might be summarized thus: Science is complex; yet it must become manageable. It can be managed better with the help of a few scientists with training in many sciences. A few such scientific generalists can be trained tomorrow with the courses at hand. To make science more manageable, we must perform a new and difficult synthesis on a higher level of organization.

Photoproduction of Molecular Hydrogen by *Rhodospirillum rubrum*

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THE PHOTOSYNTHETIC, nonsulfur purple bacterium, *Rhodospirillum rubrum* (strain SI)[2] will grow anaerobically upon illumination in a synthetic medium consisting of pure organic substrates, mineral salts including ammonium chloride, and a trace of biotin (*3*).[3] The organic substrate can be any of a large variety of compounds. Substrates more oxidized than carbohydrate are decomposed with a net production of CO_2 during growth. Aside from CO_2 and cell material, no other products have been observed in appreciable quantity. However, *R. rubrum* grown photosynthetically on certain oxidized substrates, with glutamate or aspartate instead of ammonia as a nitrogen source, exhibits in addition to CO_2 evolution a vigorous production of hydrogen.

In a preliminary survey, the only compounds so far found to be effective in evoking hydrogen production in growing cultures are malic, fumaric, and succinic acids. Of several dozen substrates tested at pH 6.6 with resting cells derived from hydrogen-producing cultures, only malic, fumaric, oxaloacetic, and pyruvic acids are effective. The magnitude of the hydrogen evolution from malic acid is of the order of one mole per mole of added substrate. Succinic acid has been tested with resting cells using pH values

[1] Predoctoral fellow of the American Cancer Society, recommended by the Committee on Growth of the National Research Council, 1947–1949. Present address, Department of Microbiology, Western Reserve University Medical School, Cleveland, Ohio.

[2] Original culture obtained through the courtesy of Prof. C. B. van Niel, Hopkins Marine Station, Pacific Grove, California.

[3] Hutner studied growth under aerobic conditions only. However, it appears that anaerobic growth requirements are similar.

varying from 5.7 to 8 because of the discrepancy in response of resting cells and of growing cells to this substance. Although extensive CO_2 evolution is observed over most of this range, no H_2 evolution is noted with succinic acid as substrate. This point is being investigated further.

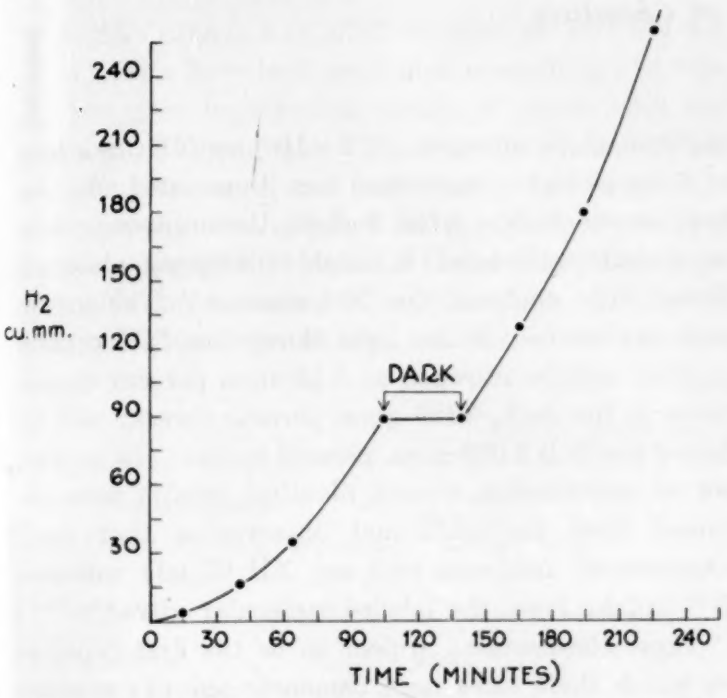

FIG. 1. Photochemical production of H_2 by *Rhodospirillum rubrum* (SI): 50 mm³ of washed cells was suspended in 2 ml M/20 phosphate buffer (pH 6.6) and 5 mg of D,L-malate was tipped in at zero time. The center well contained 0.2 ml of 10% KOH; the gas space was filled with 100% helium.

When the gas phase in resting cell experiments is helium, argon, or hydrogen, a vigorous photoproduction of molecular H_2 is observed. A typical experiment is shown in Fig. 1, which demonstrates the results obtained with conditions as noted in the legend. In the presence of nitrogen there is no evolution of H_2. The possibility that a slight oxygen contamination of the nitrogen is responsible for the inhibition has been eliminated in three ways. First, a gas mixture consisting of 1 percent oxygen plus 99 percent helium fails to repress H_2 production. Second, nitrogen completely freed of oxygen (99.99 percent N_2) inhibits H_2 evolution. Third, a mixture of pure nitrogen (0.1 atmosphere) and helium (0.9 atmosphere) inhibits H_2 production. In addition it has been found that ammonia abolishes H_2 production under helium or hydrogen. Thus H_2 production is not observed if ammonium salts or molecular nitrogen are present. This effect of ammonia brings to mind nitrogen-fixing organisms, in which combined nitrogen inhibits production and activity of hydrogenase (*4*). The possibility exists that there may also be a hitherto unsuspected nitrogenase system in *R. rubrum*. This is now being investigated, using molecular nitrogen labeled isotopically.

The production of hydrogen during normal photosynthesis by either growing or resting cells of *R. rubrum* is unusual in that there is always present a large amount of CO_2 which can be reduced with hydrogen photochemically by these organisms, as can be demonstrated with resting cells.

Hydrogen evolution is dependent on exogenous substrate, is not inhibited at high light intensity, and does not require a prolonged adaptation period. Thus, photoproduction of hydrogen by *R. rubrum* differs from the only instance of photoproduction of hydrogen reported previously. Gaffron and Rubin (*2*) observed that in the green alga, *Scenedesmus,* an endogenous production of hydrogen of low magnitude occurred at low light intensity after long anaerobic incubation of these ordinarily aerobic organisms in the absence of CO_2, or in the presence of CO_2 when dinitrophenol was added. There is also to be remarked as a point of difference the unexpected effect of molecular nitrogen in inhibiting the H_2 evolution noted in *R. rubrum.*

Attempts to link hydrogen evolution to a formic hydrogenlyase system have failed. Growth in the presence of formate produces organisms which will evolve hydrogen in the dark with formate as substrate and with N_2 as the gas phase. However, no photoproduction of H_2 has been observed with formate. It may be recalled that fermentative production of H_2 by microorganisms is ordinarily inhibited by H_2 (*1*), whereas this is not the case with *R. rubrum.*

The data at hand do not permit of a decision as to the source of the photohydrogen. As a working hypothesis, it may be assumed that the substrate employed is the source, on the basis of the substrate specificity observed. The possibility of testing this hypothesis using labeled hydrogen is remote but is being considered.

In conclusion, it appears that *Rhodospirillum rubrum* under the influence of light and in the presence of a single organic substrate can liberate hydrogen as a photosynthetic product. This hydrogen evolution is linked to nitrogen metabolism and perhaps even to a nitrogenase system. It is hoped that further work now in progress with labeled nitrogen, hydrogen, and carbon will clarify the mechanisms involved in this production of molecular hydrogen during hydrogen transfer in photosynthesis.

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Evidence for a Nitrogenase System in the Photosynthetic Bacterium *Rhodospirillum rubrum*

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IT HAS BEEN DEMONSTRATED that the non-sulfur purple bacterium, *Rhodospirillum rubrum* (strain SI) will produce molecular hydrogen as a major photosynthetic product during illumination in certain media (*1*). This phenomenon does not occur when nitrogen is present either in the elementary form or as ammonium ion (*1*). These observations suggest the existence in these organisms of a nitrogenase or nitrogen-fixing system, hitherto unsuspected.

Evidence has been obtained using molecular nitrogen labeled isotopically with N^{15} which appears to provide unequivocal support for the existence of a light-stimulated nitrogenase system in *Rhodospirillum*. In one set of experiments, 3-day-old H_2-producing organisms were harvested by centrifugation, washed twice with *m*/20 phosphate buffer (pH 7.2) and suspended in a neutral medium containing $MgSO_4$, phosphate buffer, trace elements, biotin and D,L-malic acid. The bacterial suspension was divided into three 10-ml portions. Two portions were placed in 75-cc Warburg vessels on a vacuum line. The third portion was boiled and the dead organisms so obtained were placed in the third vessel on the vacuum line to provide a control. After evacuating and flushing the vessels and vacuum system several times with helium, the vessels were filled to 0.1 atmosphere with labeled N_2 (30% N^{15}) and 0.9 atmosphere helium. The nitrogen was generated from Eastman Kodak NH_4NO_3 (30% N^{15} in the NH_4 group) with alkaline NaOBr and freed of all combined labeled nitrogen (NH_3 or N oxides) by passage through two liquid air traps. Control experiments revealed no detectable NH_3 in the elementary nitrogen ($< 2 \times 10^{-3}$ mg NH_3 in a total of 6 mg as N_2). One vessel was illuminated, one was kept in the dark. After 6 days, the organisms were separated, and total Kjeldahl nitrogens obtained. These were analyzed for N^{15} content.[2] The organisms maintained in the light showed an N^{15} content in total cellular nitrogen of 3.14 atom percent excess; those in the dark, 0.189 atom percent excess; and the boiled controls 0.008 atom percent excess. In another set of experiments almost identical results were obtained with the additional observation that small amounts of ammonia (0.5 mg NH_4Cl/ml) inhibited N^{15} uptake from the labeled molecular nitrogen.

These observations appear to be the first reported in which there have been demonstrated (1) a nitrogenase system in photosynthetic bacteria, (2) a specific effect of molecular nitrogen on hydrogenase activity, and (3) a stimulating effect of light on turnover of molecular nitrogen. These observations have been confirmed in the laboratories of R. H. Burris and P. W. Wilson at the University of Wisconsin. We wish to express our appreciation for their wholehearted cooperation.

It has been ascertained that the N^{15} uptake observed is the result of a net fixation of nitrogen. An illuminated suspension of *R. rubrum* maintained for 30 days in an atmosphere of molecular nitrogen and hydrogen and in a medium devoid of all combined nitrogen except for a minimal quantity of yeast extract has shown a seven-fold increase in cellular nitrogen gained at the expense of molecular nitrogen.

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[1] Predoctoral fellow of the American Cancer Society, recommended by the Committee on Growth of the National Research Council, 1947–1949. Present address, Department of Microbiology, Western Reserve University Medical School, Cleveland, Ohio.

[2] We are indebted to Prof. D. Rittenberg and Mr. I. Sucher, Columbia University, and to Dr. Mildred Cohn, of Washington University, for the N^{15} analyses.

A Microorganism Exhibiting a Growth Requirement for Peptides[1]

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IN SEVERAL RECENT PUBLICATIONS (*2, 3, 4*), data have been presented concerning the relative growth-promoting action of amino acids and peptides for appropriate mutant strains of *Escherichia coli*. In the case of one mutant, a *prolineless* strain, better growth was obtained in a medium containing L-proline peptides than in a medium containing an equimolar concentration of L-proline (*3*). While this enhanced growth-promoting activity of the proline peptides may be due to their direct incorporation into the bacterial proteins, other possible explanations cannot be excluded. Thus, it may be that, in the course of the bacterial growth, a portion of the free proline is converted to products that are not growth factors for the mutant, and that this conversion is prevented by the linkage of the proline residue in a peptide. Also, the possibility must be considered that the presence of proline in peptide linkage aids more directly in the incorporation of this amino acid in the bacterial proteins, perhaps by "transpeptidation" reactions. Whatever the correct explanation turns out to be in the case of the *prolineless* mutant, it may be expected that the closer study of this and other bacterial strains that exhibit characteristic growth requirements for peptides of well-defined structure will throw valuable light on the metabolism of peptides in living systems.

In the present communication, the authors wish to report preliminary studies on a microorganism which, under specific experimental conditions, grows in the presence of the dipeptide L-leucylglycine, but does not grow in the presence of a mixture of L-leucine and glycine, and grows only poorly in the presence of L-leucine. This microorganism was obtained from an unsterilized solution of L-leucylglycine in 0.9-percent NaCl which had been kept at room temperature for several weeks.[2] When a loopful of the turbid dipeptide solution was plated out on nutrient agar, only a

TABLE 1

GROWTH RESPONSE OF BACTERIAL STRAIN SF

Test compound	Growth* in saline			Growth* in saline-glucose		
	48 hr	72 hr	96 hr	48 hr	72 hr	96 hr
L-Leucine	0.009	0.020	0.026	0.032	0.027	0.018
D-Leucine	—	—	—	—	—	—
DL-Leucine	—	—	—	—	—	—
L-Leucylglycine	0.085	0.122	0.146	0.069	0.127	0.130
L-Leucine + glycine	—	—	—	—	—	—
D-Leucylglycine	0.004	0.004	0.004	—	0.002	0.006
L-Leucylglycylglycine				0.032	0.071	0.131
L-Leucylglycine + glycine	—	—	—	—	—	—
Glycyl-L-leucine	—	—	0.002	0.018	0.023	0.027
Glycyl-L-leucine + glycine	—	—	—	—	—	—
Acetyl-L-leucine†	—	—	—	—	—	—
L-Phenylalanylglycine				—	—	—
L-Phenylalanine	—	—	—	0.017	0.021	0.015
L-Phenylalanine + glycine				—	—	—
Glycylglycine	—	—	—	—	—	—
Glycine	—	—	—	—	—	—
L-Asparagine	—	—	—			
L-Alanine	—	0.062	0.080	0.032	0.041	0.042
L-Glutamic acid†	0.052	0.067	0.072	0.029	0.039	0.044
L-Isoleucine	—	—	—	—	0.012	0.018
L-Valine	0.148	0.213	0.228	0.110	0.098	0.069
NH_4Cl†				0.012	0.014	0.009
NH_4Cl† + glycine	—	—	—	—	—	—

* The extent of bacterial growth is recorded as the optical density of the culture, where density = 2 − log galvanometer reading. A dash indicates the absence of measurable growth.

† Neutralized with NaOH before use.

[1] This study was aided by a grant from the Rockefeller Foundation.

[2] The authors wish to express their thanks to Dr. Henry D. Hoberman, in whose laboratory the peptide solution was kept, and who kindly called our attention to the bacterial growth in the solution.

single type of colony appeared after 24 hours at 30°. A subculture of one of these colonies served as the source of the organisms used in the tests reported below. For convenience, the isolated bacterial strain will be termed "SF."

Examination of the isolate showed it to be a short, nonmotile rod which is Gram-negative and occurs singly or in pairs in Gram-stained preparations.[3] In nutrient broth containing glucose, lactose, or sucrose, it does not cause the formation of acid or gas; after 3 days, such test solutions have a pH of 8 or higher. It turns litmus milk alkaline and liquefies gelatin. The organism has been tentatively classified, therefore, as a member of the genus *Alcaligenes*.

The ability of strain SF to grow in saline solutions containing a variety of amino acids or peptides is shown in Table 1. In performing the tests, Evelyn colorimeter tubes, containing 8 cc of the test medium, were incubated at 30°, and the extent of bacterial growth was measured at intervals in an Evelyn colorimeter with filter No. 540. As is indicated in the table, one series of tests was conducted in the presence of amino acids or peptides as the sole source of carbon and nitrogen in the medium, while in a second series glucose was added as an additional potential source of carbon. When 0.9-percent NaCl alone was used as the medium, the concentration of each test substance was 0.1 M; when saline was supplemented with glucose (0.17 M), the concentration of the test substances was lowered to 0.05 M. The inocula for the tests consisted of a drop of an aqueous suspension of cells taken from a peptone-yeast extract-agar slant which had been incubated for 24 hours at 30°. Under these conditions, visible growth was not evident until 24 hours after inoculation, and significant readings with the Evelyn colorimeter were not obtained until 36–48 hours after inoculation.

The data in Table 1 show that strain SF grew equally well when L-leucylglycine was present in the medium in combination with glucose or when the peptide represented the sole carbon source for growth. No growth was noted when L-leucine and glycine were present, and the presence of L-leucine promoted the growth only slightly. It was observed that, in every case in which it was tested, glycine exerted an inhibitory effect upon the growth of strain SF. It would appear, however, that glycine is not bactericidal, since the same number of viable cells could be recovered, after 5 days' incubation, from a medium containing glycine as from a medium containing DL-leucine, in neither of which was there any visible growth. The complete failure of strain SF to grow in the presence of DL-leucine suggests that the D-isomer may act as a growth inhibitor. It is also of interest that, with D-leucylglycine, there was noted only slight growth, which may be due to the presence of a small amount of the L-form of the peptide in the commercial preparation used for these experiments.

L-Leucylglycylglycine produced a growth response similar to that noted with L-leucylglycine. Glycyl-L-leucine and acetyl-L-leucine, however, showed little, if any, growth-promoting activity. It would appear, therefore, that significant growth of strain SF in the presence of leucine peptides is favored only when the L-leucine residue is present at the amino end of an unsubstituted peptide. When the L leucine residue in L-leucylglycine was replaced by that of L-phenylalanine or of glycine, the resulting L-phenylalanylglycine or glycylglycine was inactive in promoting bacterial growth. Although further studies of the specificity of the peptide requirements of strain SF are necessary, it may be concluded from the above results that the presence in the medium of a dipeptide *per se* does not satisfy the growth requirement.

The data in Table 1 show that the organism does not have a specific requirement for leucyl peptides since L-alanine and L-glutamic acid permitted fair growth and L-valine served as a better growth factor than even L-leucylglycine. On the other hand, L-asparagine did not promote bacterial growth, and a medium containing NaCl, NH_4Cl, and glucose gave only a slight growth response. However, other tests in which the basal medium usually employed by us for *Escherichia coli* (i.e., a mixture of inorganic salts, including NH_4Cl and NH_4NO_3, glucose, and a small amount of asparagine (*1*) was used, showed that strain SF is capable of growth when glucose is the source of carbon, and ammonia and nitrate are the principal sources of nitrogen. The addition of 0.1 mM of glycine per cc of this medium completely inhibited the growth of strain SF, while a concentration of 0.001 M glycine retarded growth appreciably.

[3] The authors are indebted to Dr. C. F. Robinow for his valuable advice in the characterization of the bacterial strain.

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TECHNICAL PAPERS

Suppression of Gastric Acidity with Beta Particles of P^{32}

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Irradiation of the gastric mucosa by X-rays or gamma rays of radium has suppressed gastric acidity (*2, 3*). Such irradiation penetrates and affects not only the gastric mucosa, but also adjacent organs. The liver and small intestine are more sensitive than the gastric mucosa to radiation (*1*), and damage to these adjacent organs may occur if large doses of X-rays or gamma rays are directed to the stomach.

To suppress acidity, it would therefore seem more suitable to restrict radiation to the gastric mucosa. This is accomplished by the topical application to the mucosa of a radiation source emitting rays which are absorbed almost completely by the stomach. A suitable source is the radioactive isotope of phosphorus, atomic weight 32, for this isotope emits beta particles whose maximum range in tissue is about 8 mm. An applicator was devised to apply P^{32} topically to the mucosal lining of Heidenhain stomach pouches in dogs.

The applicator was a thin rubber bag inflated to a volume of 50 cc with air, sprayed with rubber cement, and covered with flocs of short cotton fibers, so that the covering resembled a smooth coat of felt. The inflated balloon was dipped into a solution containing P^{32} and allowed to dry. By a series of these dippings and dryings as much as 25 mc of P^{32} was adsorbed uniformly on the flocculate surface of the balloon. The balloon was then deflated, covered by a rubber condom, inserted into the Heidenhain pouch, and reinflated with air to its original volume of 50 cc. The condom covering the balloon prevented loss of P^{32} from the felt-like surface and only adsorbed 4% of the beta activity.

A series of control observations were made on the secretion of Heidenhain pouches with histamine as a stimulus. Then the pouches were irradiated.

After exposure to this beta radiation for periods of 2–6 hr the balloon was deflated and withdrawn. Subsequently, acid secretion tests were again made with the same stimulus of histamine used in control secretion observations. The pouch mucosa was observed by cystoscope, and multiple punch biopsies of the mucosa were made in some of the animals at frequent intervals.

The maximum thickness of the mucosa of these Heidenhain pouches is about 4 mm, and the average thickness is about 3 mm. At a depth of 3 mm the dose is about 25% of the dose in the first mm of mucosa. The thickness of the whole pouch wall is about 7–8 mm, at which depth the dose has decreased to less than 2% of the dose to the first mm of mucosa. Preliminary histological examination of a post-mortem specimen indicates that there is no discernible change in the serosa of the pouch when the mucosa has been heavily irradiated.

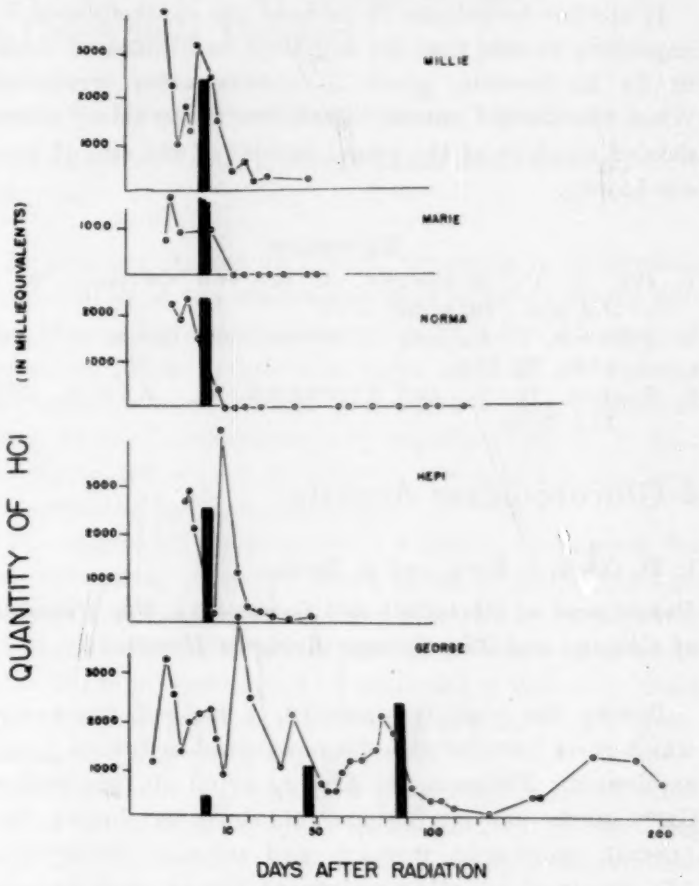

FIG. 1.

Radiation was followed after a few days by a decrease in total secretion as well as a decrease in quantity and concentration of HCl in the pouches of all five dogs studied. Two of these five dogs had anacid pouches, and the other three were hypoacid. Intubation of the stomach during the course of these secretion tests with histamine stimuli showed that the secretion of the true stomach had a pH of 1.0 at the same time the pouch secretion had a pH of 7.0.

Fig. 1 shows the change in pouch acid secretion after radiation. All radiation exposures yielded doses in the magnitude of 20,000 to 25,000 equivalent roentgens to the first mm of tissue except for the preliminary radiation on George (lowest graph in Fig. 1).

The heavy vertical bars in this instance represent respectively 1,800, 12,000 and 25,000 equivalent roentgens in the first mm of mucosa. Although the decrease in acidity with the lower doses was not apparent, the higher doses invariably decreased pouch acidity. All other vertical heavy bars in Fig. 1 represent radiation

[1] Dazian Fellow in Radiology.

[2] The author gratefully acknowledges the assistance and cooperation of Franklin Hollander, Head, Gastroenterology Research Laboratory of the Mount Sinai Hospital.

exposure of 20,000 to 25,000 equivalent roentgens to the first mm of tissue. A few weeks after radiation, the quantity of acid secreted had decreased to levels ranging from anacidity to 10% of the quantity secreted before radiation. The longest period of observation after radiation in any animal was 125 days.

There were no changes in blood count, weight, or general condition of the animals which could be attributed to the radiation.

In summary, the gastric mucosa of Heidenhain pouches of five dogs was irradiated with beta particles of P^{32}, with a resultant marked decrease in the quantity of acid in the pouch secretion.

If similar techniques in humans are contemplated it is important to note that the dog Hepi had return of acidity in its Heidenhain pouch 3 months after irradiation. When the animal was sacrificed two weeks later, autopsy showed an ulcer of the pouch mucosa at the site of previous biopsy.

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β-Glucuronidase Activity

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During the past few months, a method has evolved which gives promise as a diagnostic aid in female genital carcinoma. Fishman (*1*) first reported an increased activity of the enzyme β-glucuronidase in carcinoma tissue (breast, esophagus, stomach, and colon). Subsequently (*2*), results from other malignant tissues were added to his series. The possibility of measuring the tissue activity of β-glucuronidase from the more accessible pelvic malignancies (vulva, vagina, and cervix) as a diagnostic aid is self-evident. Furthermore, if present indications prove correct, the vaginal fluid which bathes the cervix and vagina should become a rich source of this enzyme in the presence of a lower genital tract malignancy.

Accordingly, β-glucuronidase assays were made on the various genital tissues and on vaginal fluid for the purpose of establishing the range of activity in histologically benign lesions, and in carcinoma. Tissues were weighed, homogenized in water, and the centrifuged homogenates assayed, using phenolphthalein glucuronide as substrate, according to the method described by Fishman, Springer, and Brunetti (*3*). Using a pipette, 0.1-ml portions of vaginal fluid were suspended in 3 ml of distilled water or Tyrode's solution. Assays were made on both uncentrifuged specimens and on the centrifuged supernatants. Values were expressed as γ of phenolphthalein liberated per g of tissue or ml of vaginal fluid per hr. Our results are tabulated.

In the absence of pregnancy, the range of β-glucuronidase activity in those cervices without histological evidence of malignancy was from 23 to 330 γ of phenolphthalein per g tissue per hr (Table 1). The upper limit of this group was significantly less than the lowest value for cervical carcinoma, 543 γ, #299510 (Table 2).

TABLE 1

Glucuronidase Activity

Tissue	Cases	γ of β-Glucuronidase*	
		Range	Average
Benign cervix	13	23– 330	142
Pregnant cervix	8	221– 591	384
Malignant cervix	6	543–2790	1274

* β-Glucuronidase expressed as γ phenolphthalein liberated per g of tissue per hr.

A variety of clinical and pathologic diagnoses were found among the benign cervices studied. Most were from cervical biopsies obtained to rule out malignancy. Others included senile vaginitis, cervical erosion, acute and chronic cervicitis, and some apparently normal organs. A histologic examination of the tissue adjacent to the area assayed established an absence of malignancy. The activity of b-glucuronidase in vaginal mucosa (nonpregnant) was similarly low. The enzyme activity of pregnant cervix (at term) was higher, and there was some overlapping with the malignant group. No explanation is offered at the present time for this finding.

TABLE 2

Glucuronidase Activity of Untreated Carcinoma Tissue

Identification	Microscopic diagnosis†	γ of β-Glucuronidase‡
436773	Sq. ca. cx.	934
438049	Sq. ca. cx.	2790
159341	Sq. ca. cx.	1634
452839	Sq. ca. cx.	847
299510	Sq. ca. cx.	543
45424	Sq. ca. cx.	897
A.M.*	Sq. ca. vag.	688
A.S.*	Sq. ca. vag.	680

* Patient at another hospital.

† Sq. ca. cx.—Squamous carcinoma of cervix; Sq. ca. vag.—squamous carcinoma of vagina.

‡ β-Glucuronidase expressed as γ phenolphthalein liberated per g of tissue per hr.

The malignant tissues studied are tabulated in Table 2. The range of activity was high. Two specimens of endometrial carcinoma were assayed. These measured 11,930 and 6,370 γ. The lower of these values is within the range of glucuronidase activity for endometrium in women with normal menstrual periods (895 to 9040 γ) (*4*) and both are well within the range for endometrium in patients with functional uterine bleeding (1,180 to 20,050 γ) (*5*). The activity of β-glucuronidase in normal ovary and in benign ovarian tumors varied greatly. It

is our impression that the assay for tissue glucuronidase will prove of more value in lower genital tract carcinoma.

In the presence of untreated lower genital tract carcinoma, the vaginal secretion was uniformly high in glucuronidase activity, the lower range being 477 γ uncentrifuged (Table 3). It is apparent from studies on vaginal secretion obtained from women with benign lesions that false positive tests occurred (Table 4). These were obtained principally from patients who were pregnant and from patients with a trichomonas vaginitis. Following irradiation therapy for genital carcinoma, the vaginal fluid was less active (in the absence of a recurrence) than in the untreated group. This observation suggests the use of vaginal fluid assays as a method of follow-up. Results from the centrifuged supernatant fluid were generally lower than those of the uncentrifuged specimen. Thus, it may be inferred that more glucuronidase activity was associated with the solid (cellular) component of the suspension. It was found that the centrifuged supernatant fluid of suspensions in Tyrode's solution was less active than suspensions in distilled water. This is probably due to less laking of the cellular component in Tyrode's solution. These studies are being continued on a larger scale.

TABLE 3

GLUCURONIDASE ACTIVITY IN VAGINAL FLUID OF UNTREATED CARCINOMA

Identification	Microscopic diagnosis†	γ of β-Glucuronidase‡	
		Uncentrifuged	Centrifuged
432565	Sq. ca. cx.	1458	
		1368	
436773	Sq. ca. cx.	498	240
438049	Sq. ca. cx.	477	136
439485	Sq. ca. cx.	900	459
436773	Sq. ca. cx.	1335	1010
299510	Sq. ca. cx.	1412	962
140393	Endomet. Car.	1218	493
A.M.*	Sq. ca. vag.	883	
45424	Sq. ca. cx.	1930	665

* Patient from another hospital.

† Sq. ca. cx.—squamous carcinoma of cervix; endomet. car.—endometrial adenocarcinoma; sq. ca. vag.—squamous carcinoma of vagina.

‡ β-Glucuronidase expressed as γ of phenolphthalein liberated per ml of vaginal fluid per hr.

TABLE 4

GLUCURONIDASE IN VAGINAL FLUID OF BENIGN LESIONS

γ of β-Glucuronidase*	Number examined	
	Uncentrifuged	Centrifuged
over 501	4	1
301–500	3	2
101–300	8	5
51–100	11	2
1– 50	17	19
0	7	23
Total	50	42

* β-Glucuronidase expressed in a frequency table as γ of phenolphthalein liberated per ml of vaginal fluid per hr.

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The Nature of the Pigmented Sheath in *Drosophila* Tumors[1]

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In previous studies of tumors occurring in *Drosophila melanogaster* it has been noted that those in larvae several days old are surrounded by a pigmented coat, and appear as black, or brownish-black masses. In younger specimens, tumors, though present, lack the pigmented coat. It has been suggested by some workers (*2–4*) that the pigmented sheath is melanin, but this has not been substantiated by chemical tests.

The nature of the pigment is a matter of interest for several reasons. First, it seems to act as a limiting barrier against the growth of the tumor mass. Second, for detailed cytological study of tumors, it would be of great value if the pigment could be inhibited or delayed. Good cytological pictures may be obtained now only from tumors in quite young larvae.

Since melanin is the likeliest possibility in insect material, it was decided to test for it first, using two tests suggested by Cowdry (*1*). One is an oxidizing process employing $KMnO_4$ followed by oxalic acid; the other involves bleaching in the presence of concentrated NaOH.

Flies of tumorous strain "bw tu" were placed in half-pint containers, the caps of which held on their inner surfaces blocks of molasses agar seeded with yeast. The bottles were inverted and the flies could thus feed and deposit their eggs on the readily removable agar blocks. Caps were changed daily, the blocks each time being transferred to Petri dishes containing molasses agar well seeded with yeast. Here the eggs were allowed to hatch, and larvae to develop. Approximately 80–90 hr following transfer to the Petri dishes, tumerous larvae showed heavy deposits of pigment surrounding the neoplasms, and were considered ready for examination.

By flooding the Petri dishes with water, the larvae could be pipetted out and transferred to Syracuse watch glasses for microscopic study. Tumors were teased out with dissecting needles under broad field microscope and

[1] The work reported here is part of a research project supported by a grant from the Cancer Research Grants Branch, Division of Research Grants and Fellowships, National Institutes of Health, Bethesda, Maryland.

transferred by means of a fine pipette to Stender dishes containing either concentrated NaOH or 0.1% $KMnO_4$. At the end of 24 hr in NaOH, all tumors were found to be completely decolorized. This may be regarded as a positive reaction, since melanin is bleached by concentrated NaOH.

Tumors in $KMnO_4$ were allowed to remain for 24 hr, then rinsed in several changes of distilled water, and immersed in 0.3% oxalic acid. In all cases, after 12–24 hr in oxalic acid no trace of the dark masses could be found, the pigmented sheath evidently having been completely oxidized. This too may be regarded as a positive test.

Since the results in both cases are those expected of melanin, it would appear that the assumptions previously made concerning the nature of the pigment are correct.

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An Internal Geiger Counter for the Assay of Low Specific Activity Samples of Carbon 14 and other Weak Beta Emitters in Biological Samples[1]

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The limiting factor in biological experiments with radioactive tracers is the great dilution of the isotope. Further increases in the specific activity of the isotopic compound are often impossible because of its limited availability or because of the biological effects of the radiations. Improvements in counting techniques offer the only practical solution. The procedure described here permits statistically valid analyses of samples having one-fifth or less the activity necessary for mica-window tubes.

The windowless Geiger tube of the continuous gas flow type shown in the accompanying figures (Figs. 1 and 2) permits the counting of all particles escaping from the sample. A satisfactory counting gas is a mixture of helium and alcohol vapor. The helium is bubbled through absolute ethyl alcohol kept at 0° C in an ice bath and the gas mixture passed through the counter.

The counter can be successfully operated with commercially available scaling circuits. The material to be assayed must be spread in fairly uniform thickness on a flat surface or shallow cup within a measured area. Samples of tissues are prepared by spreading an aqueous homogenate of the tissue on a flat copper disk of 2-in. diameter which has been cleaned with ether and oxidized in an oven at 160° C overnight. The spreading may conveniently be done while the copper disk is revolving at the rate of 5 to 20 rpm on a turntable and under a gentle current of dry air. Samples of blood, urine, and solutions or suspensions of water-soluble or insoluble

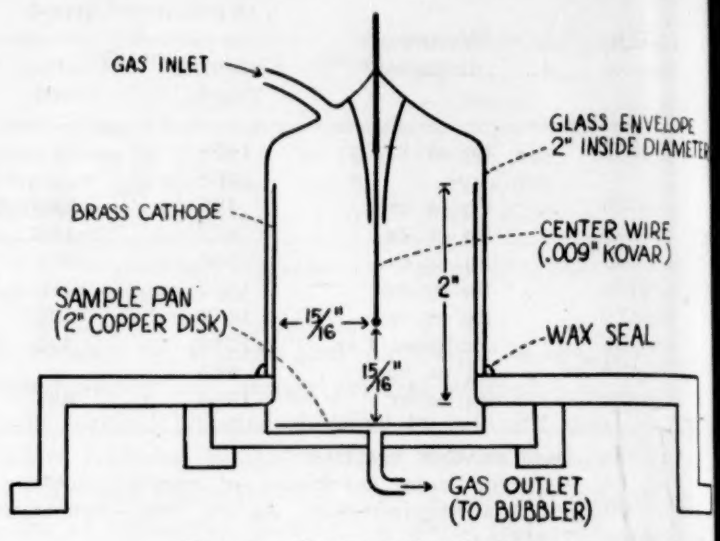

FIG. 1. Cross-sectional view.

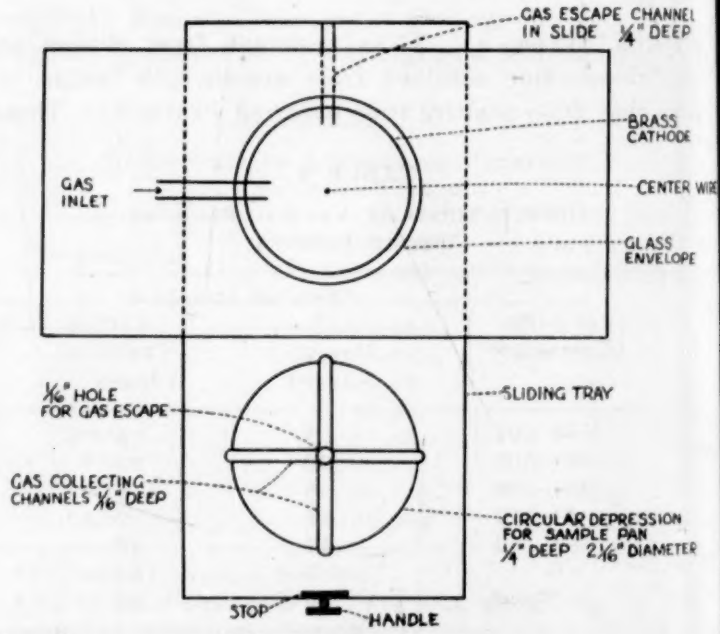

FIG. 2. Top view.

substances may also be spread out in this manner. The sample so prepared may then be inserted in the sliding tray and pushed into the counter.

A simplified version of the Geiger tube can be made omitting the sliding arrangement for insertion of the sample and including a side arm for a gas outlet. In this case the sample is placed on the copper disk as usual, the copper disk on a flat brass plate, and the counter over the sample. The tube can be made relatively air-tight by pressing down on the glass tube or by using stopcock grease or wax at the junction of the glass tube and brass plate. Since the counting gas is always under a slight positive pressure, small leaks are of no impor-

[1] This work was aided by grants from the Life Insurance Medical Research Fund, the United States Public Health Service, and the Dr. Wallace C. and Clara A. Abbott Memorial Research Fund of the University of Chicago.

tance. This counter may also be used for monitoring relatively flat surfaces such as laboratory tables for low-energy beta particles.

The plateau has less than a 4% rise per hundred volts from 1350 to 1550 volts. In this laboratory, the background of the counter shielded with 2 in. of lead is 28 cpm at 1375 volts. A 10-mg sample of barium carbonate containing 0.0005 μc of C^{14} spread on a 10-cm² surface, gave a counting rate of 564 cpm (uncorrected) at 1375 volts. The sensitive area available on the sample holder is 20 cm². The counting gas is inexpensive and readily available. The counter is simple to construct or may be obtained commercially.[2] The time required for replacing a sample and flushing the counter is less than 3 min.

Embryo Size and Productivity in Segregating Generations of Tomatoes[1]

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Much work has been done on size of embryos and their relationship to plant vigor in both inbred and F_1 hybrid populations; but the authors are not aware of similar experimental data in segregating generations except Faberge's (*4*) suggestion that early vigor in F_2 generations may be caused solely by initial seed weight advantage. Ashby (*1*) postulated that hybrid vigor in F_1 tomato lines was due to the possession by the hybrid of a larger embryo than that of the parental strains. Luckwill first confirmed this (*9*), but later (*10*) found evidence to indicate that no general relationship exists between embryo size and increased physiologic efficiency of F_1 hybrids. Other workers also have disagreed with Ashby's theory (*3, 5, 6, 8, 11, 13*).

Some experiments (*1, 2, 7, 8, 11, 13, 14*), however, have indicated that many F_1 lines showing hybrid vigor had larger seed or embryo size than the parental strains from which the hybrids were developed. Hatcher (*6*) has shown that size of seed in tomatoes is determined to a great extent by the number of seeds in a fruit. Natural self-pollination results in greater seed set per fruit than cross pollinating by hand; therefore, seeds from self-pollination are generally smaller in size. This does not explain the increase in size of a portion of the F_2 seeds (i.e., those produced by F_1 plants). Undoubtedly genetic control is also a factor in embryo size.

If it is assumed that in certain specified F_1 lines large size of seed is associated with hybrid vigor as measured in yields of fruit, and that such an association is carried into the segregating F_2 generation, a method is suggested whereby hybrid tomato seed may be produced by selection of seed harvested from F_1 fruits. It is possible to theorize further that if no relationship exists between seed size in tomatoes and productivity in an F_1 line showing considerable hybrid vigor, seed size and vigor may still be related in the segregating generation where transgressive segregation may occur. The first measurable evidence of vigor in segregating progenies might presumably be in larger embryo or seed size.

TABLE 1

AVERAGE WEIGHT PER SEED IN MG

Generation	Diameter of seed: 3000 + μ	2500–3000 μ	2000–2500 μ	Mean
P_1 Rutgers	3.43	2.89	2.38	2.90
P_2 Pritchard	3.43	3.15	2.56	3.05
F_1 R × P	3.78	3.31	2.91	3.33
F_2 R × P	3.69	3.01	2.29	3.00
Mean	3.58	3.09	2.52	...

Preliminary results have supported these possibilities. The correlation coefficients computed between seed weight and embryo weight and between average seed diameter and embryo weight were 0.978 and 0.867 respectively. Both exceed the 1% level of significance. Average seed diameter has, therefore, been used as a measure of seed weight, which in turn was used as a measure of embryo size. One-pound seed lots of two inbred strains of tomatoes, their immediate cross, and seed taken from F_1 generation fruits were sieved through soil screens with spherical openings averaging 3000, 2500, and 2000 μ. Table 1 indicates the average diameter and weight for each size class.

TABLE 2

EARLY AND TOTAL YIELDS IN TONS PER ACRE

Generation and size of seed	8/13/48 to 9/2/48		8/13/48 to 9/30/48	
Mean of Rutgers	2.4		17.3	
Mean of Pritchard	5.9		18.1	
F_1 from seed averaging 3.78 mg	7.0	$\overline{F_1} = 6.1$	20.6	$\overline{F_1} = 19.6$
F_1 from seed averaging 3.31 mg	6.2		20.1	
F_1 from seed averaging 2.91 mg	5.2		18.1	
F_2 from seed averaging 3.69 mg	5.6	$\overline{F_2} = 5.6$	19.4	$\overline{F_2} = 18.7$
F_2 from seed averaging 3.01 mg	5.9		18.5	
F_2 from seed averaging 2.29 mg	5.2		18.1	
Significant difference 19 : 1 ..	0.89		1.30	
Significant difference 99 : 1 ..	1.19		....	

The average deviation in seed weight within the inbred and F_1 materials was 26.5%; in the F_2 it was 38.0%. Assuming that the deviation in the F_1 and inbred lines was environmental (*12*), then 30% of the total variation in seed producing the F_2 progenies was due to hereditary factors.

The field trials included plants grown from each seed-size class for each generation (P_1, P_2, F_1, F_2). A split-plot design having six replications was used. Information was obtained on earliness, vigor of plants, size and shape of fruits, uniformity, and yield. Yields are of

[1] Authorized for publication on January 10, 1949 as Paper No. 1500 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

[2] From the N. Wood Counter Laboratory, Box 76R1, Chesterton, Indiana.

primary importance and will be used to illustrate the preliminary results. Table 2 shows the mean yields obtained for Rutgers and Pritchard and the three seed-size classes producing the F_1 and F_2 generations of plants.

The preliminary results for this specific tomato hybrid appear to agree with the proposed hypothesis. It will be noted that the mean yield of the F_2 progenies, produced from the largest seed-size class, is comparable to the mean yield of progenies obtained from all seed sizes of the immediate cross. The smallest seed-size class producing the F_1 generation was, however, lower in production than its two larger seed classes, possibly due to accidental inclusion of a few self-pollinated seeds of the female parent, Rutgers. The fact that early yield in the smallest seed-size class was significantly less than in the other two classes also substantiates the supposition. Had the smallest class been comparable to the other two, the average total production in the F_1 generation progenies would have been 20.3 tons as compared to 19.4 for the largest seed class producing the F_2 generation progenies. More extensive field trials are planned for the coming season.

If a measurable association can be shown to exist between size of seed extracted from F_1 fruits and productivity in the F_2 generation progenies, a new method of producing hybrid seed in volume may result. Breeders of pure line tomato strains may also benefit by being able to select for vigor by seed size, thus eliminating the growing of considerable undesirable material.

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Hypersensitivity in Cold-blooded Animals. II. Salamanders

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In a study of the effect of histamine on intestinal smooth muscle preparations of fish, Dreyer (*2*) observed that histamine produced contractions in teleost but not in elasmobranch smooth muscle. In a subsequent study Dreyer and King (*3*) were able to produce anaphylaxis in several teleost species, using as antigens horse serum and egg albumen injected intraperitoneally. Similar studies using elasmobranch species proved to be impractical because of technical difficulties. A search was therefore instituted for other cold-blooded animals which would show the same inability to react to histamine stimulation as elasmobranch species and be more suitable subjects in which to attempt protein sensitization.

Previous investigations using frogs as experimental animals have yielded results which are conflicting and difficult to interpret. Friedberger and Mita (*4*) shocked frogs sensitized to sheep serum and noted that the shocked animals displayed a weakness and curious loss of muscle tone. Isolated heart and other organ preparations failed to yield clear-cut results. Arloing and Langeron (*1*) failed to note any signs of hypersensitivity in their series of frogs treated with human serum. Kritchevsky and Birger (*7*) used frogs in which the blood was replaced by a colloid-free salt solution and noted that mammalian serum showed primary toxicity for these animals. Goodner (*6*) failed to produce satisfactory *in vivo* reactions using egg albumen and horse serum as antigens but did notice in the excised heart indications of developing hypersensitization. Friede and Ebert (*5*) demonstrated passive anaphylaxis in frogs and in some instances were able to produce symptoms of hypersensitivity in frogs actively sensitized. It is suggested that these widely divergent results, to which must be added our own negative results (*3*), were perhaps due to differences in the nutrition of the various experimental animals used. In some instances, frogs which had been held all winter without feeding failed to react, whereas frogs caught and used in the summer months showed irregular reactions that possibly might be considered significant.

Because of these variations the American newt (*Triturus viridescens*) was selected as a closely related species, which could be easily kept in the laboratory, and which could be fed without difficulty. *In vitro* and *in vivo* studies of possible hypersensitization were made in these animals. It was soon found that the tiny size of newt organs made them unsatisfactory for kymographic studies, and later studies were carried out using the mudpuppy (*Necturus maculosus*). During the investigation, the newts were kept at room temperature in a closed aquarium jar, in a few inches of water with access to rocks. They were fed three times a week and would accept only live food, taking flies and earthworms readily. With the coming of cold weather they ceased to feed, and the series, which was almost completed, was discarded. The mudpuppies were kept in running water at 18° C and refused to feed when offered earthworms, sliced rabbit liver, or rat meal. They were well fed on arrival and were all used within a month; most of the earlier animals sacrificed for tissue had food in the gut.

Injections were made intraperitoneally at a point midway between the front and hind legs. Horse serum was the only antigen used. This was about 10 months old but had been stored at −20° C without preservative. Sensitizing and shocking doses, which ranged from 0.05 to 0.10 ml for the newts and 0.20 to 0.30 ml for the mud-

uppies, were spaced at irregular intervals, never less han 10 days apart.

In vitro studies were made on "Straub heart" or rips of intestine or stomach, using the usual recording ethods for these preparations. All chemicals used in he kymographic studies were made up in frog saline olution.

A series of 14 American newts were injected intra-eritoneally with 0.05 ml of horse serum in an attempt o sensitize them. At the same time four other newts ere set aside uninjected as controls and were held under onditions comparable to those of the test group. All of he test animals were reinjected, using 0.10 ml of horse erum; two each at intervals of 18, 23, 28, 42, 48, 55, nd 65 days after the initial injection. A control animal as injected with the same dose of antigen along with he first four pairs of test animals injected. No demon-rable evidence of hypersensitivity was observed. Simi-rly, the injections of the control animals produced no esults. Two animals died subsequent to injection, but utopsy revealed evidence of trauma that could account or the deaths. Three animals received three injections ach at irregular intervals, without reaction.

The injection of test and control animals with 5 γ of istamine phosphate produced no reaction, but 10 γ pro-uced a transitory reaction of obvious distress.

Muscle preparations using a section of the duodenal nd of the intestine were disappointing, because the small ize of the material rendered kymographic studies diffi-ult. However, it appeared that in three muscle prepara-ions studied, histamine 10 γ, epinephrine 10 γ, and horse erum 0.2 ml produced no demonstrable effect. Barium hloride, 2% solution, produced significant contractions f the gut, showing the ability of the muscle to respond. Heart and stomach preparations were not studied in the ewt because of the technical difficulties involved. In iew of the results of the organ studies, it was felt that he reaction *in vivo* with 10 γ histamine was an artifact aused by the relatively large size of the dose ad-ministered.

Of five mudpuppies obtained, two were sacrificed, with-ut previous attempts to sensitize them, for kymographic tudies of heart, stomach, and intestine; and three were njected intraperitoneally with 0.2 ml of horse serum. As this produced no evident reaction, the animals were einjected four days later, using 0.25 ml antigen in an ffort to build up the allergic state. Again there was o immediate reaction, but one animal died two days ater; autopsy showed blood in the abdomen, the cause f which was probably the trauma of injection. The emaining two animals were injected again 18 days after he first sensitizing dose and showed no symptoms of hock. Five days later these animals were sacrificed for tudy of isolated organ preparations.

In kymographic studies of Straub heart preparations f both normal and serum-injected animals, histamine n doses as high as 10 γ and horse serum in 0.2-ml doses failed to exert any effect on the contractility of the heart. Similar doses of histamine and horse serum failed to produce demonstrable responses when administered to stomach or intestinal preparations. One γ of epine-phrine produced a marked increase in the amplitude of the myocardial contractions, while the same amount of acetylcholine depressed the contractility of the heart. These reactions were in agreement with those observed using fish Straub heart preparations (*2*) and our un-published experiments with frog preparations.

As a result of these data it can be concluded that, while teleost fish have the ability to become sensitized to protein antigens, are able to show histamine shock, and can show smooth muscle contractions in the preparations *in vitro* treated with histamine, the American newt and the mudpuppy have none of these characteristics. Acetyl-choline depresses the activity of frog, salamander, and fish heart, but seems to play no role in hypersensitization. It is suggested that these data be used as additional evi-dence of the role of histamine in anaphylaxis.

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Inactivation of Amino Acids by Autoclaving[1]

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Recent work has shown that cystine is the only amino acid partially destroyed by autoclaving casein for 20 hr at 15 lb pressure (*3*). Lysine, arginine, and tryptophan suffer partial destruction when casein (*5*) or soy globulin (*6*) is refluxed for 24 hr in a glucose solution, or when soybean oil meal is autoclaved for 4 hr (*7*). The amounts of aspartic acid, isoleucine, lysine, methionine, and threonine liberated by enzymatic digestion from casein *in vitro* are decreased after autoclaving (*3*), as are all of the amino acids in soybean oil meal (*7*).

Evans and Butts (*1*) found that autoclaving causes two types of inactivation of lysine, one a reaction of the lysine with sucrose to destroy it and the other a reaction with protein to render it unavailable after enzymatic digestion *in vitro*. Moreover, methionine reacts with sucrose or glucose to form a linkage not hydrolyzed by enzymes *in vitro* (*2*).

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The present investigation was carried out to study the mechanism of amino acid inactivation by autoclaving. Soybean protein,[2] and a mixture of 8 g of soybean protein and 2 g of sucrose, were autoclaved for 4 hr at 15 lb pressure. Unautoclaved protein was used as a control. Total and available amino acid contents of the proteins were determined by microbiological assay after either acid or enzymatic digestion *in vitro* as described previously (*1, 2*). *Leuconostoc mesenterioides* P–60 was used for lysine, methionine, cystine, and aspartic acid assays; *Lactobacillus arabinosus* 17–5 for leucine, isoleucine, valine, threonine, phenylalanine, and glutamic acid; *Streptococcus faecalis* R for histidine; and *Lactobacillus casei* for arginine. The media of Sauberlich and Baumann (*8*) were used for all assays except methionine and cystine for which the oxidized peptone medium of Lyman, *et al.* (*4*) was used.

The results are summarized in Table 1. None of the amino acids was significantly destroyed by autoclaving soybean protein alone; but when the protein was mixed with sucrose prior to autoclaving, over 40% of the diamino acids, lysine and arginine, was destroyed. This destruction was caused, apparently, by a reaction of the free amino groups with sucrose, because more than 45% of each of the free amino acids used, except cystine, was destroyed when added to the protein-sucrose mixture before autoclaving (Table 2). Protein-bound cystine was also partially destroyed (22%) by the treatment.

Autoclaving the mixture of soybean protein and sucrose, decreased the amounts of all amino acids liberated by enzymatic digestion *in vitro*, some to a greater extent than others. Aspartic and glutamic acids were

TABLE 1

AMINO ACID INACTIVATION CAUSED BY AUTOCLAVING SOYBEAN PROTEIN ALONE OR WITH SUCROSE

	Acid hydrolysis			Enzyme hydrolysis		
	Total amino acid content %	% Lost on autoclaving	% Lost on autoclaving with sucrose	Available amino acid content %	% Lost on autoclaving	% Lost on autoclaving with sucrose
Arginine	6.91	3	42	6.62	8	55
Lysine	4.65	3	47	3.07	30	84
Histidine	2.29	8	10	1.97	16	42
Aspartic acid	5.75	7	6	1.04	37	34
Glutamic acid	17.10	2	3	4.74	24	50
Cystine	0.27	9	22	0.21	14	86
Methionine	1.12	3	2	0.62	6	41
Phenylalanine	5.17	0	0	4.00	9	14
Threonine	3.28	4	1	2.14	8	15
Leucine	7.31	2	0	6.14	8	13
Isoleucine	5.83	0	0	4.92	8	8
Valine	6.32	2	0	5.19	8	8

TABLE 2

INACTIVATION OF FREE AMINO ACIDS CAUSED BY AUTOCLAVING WITH SOYBEAN PROTEIN OR WITH SOYBEAN PROTEIN AND SUCROSE

	Percentage of added amino acid destroyed*		Percentage of added amino acid inactivated†		Percentage of added amino acid inactivated but not destroyed	
	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose	Autoclaved with soybean protein	Autoclaved with soybean protein + sucrose
Arginine	7	45	2	50	0	5
Lysine	7	56	31	75	24	19
Aspartic Acid	22	57	33	56	11	0
Cystine	8	20	30	50	22	30
Methionine	2	79	7	74	5	0
Phenylalanine	15	59	21	70	6	21
Valine	14	46	25	52	11	6

* Percentage of added amino acid destroyed was calculated from the difference in recovery of amino acid from acid digests of the autoclaved and unautoclaved materials.

† Percentage of added amino acid inactivated was calculated from the difference in recovery of amino acid from enzyme digests *in vitro* of the autoclaved and unautoclaved materials.

[2] "Alpha" protein furnished by The Glidden Company, Chicago.

also partially inactivated when the protein was autoclaved in the absence of sucrose, possibly by a reaction of their free carboxyl groups with the free amino group of lysine to give a linkage resistant to enzymatic digestion. Cystine, methionine, and histidine inactivation was primarily caused by a reaction with sucrose to form an enzyme-resistant linkage. As only small amounts of phenylalanine, threonine, leucine, isoleucine, and valine were inactivated, it appears that the amino acids which are inactivated are those with free amino or carboxyl groups, or with other active groups such as the sulfur of cystine and methionine, or the imidazole of histidine.

Representative free amino acids were added to samples of soybean protein and the protein-sucrose mixture before autoclaving. The results are presented in Table 2. No relation between the behavior of free and protein-bound amino acids is apparent. Except for lysine, cystine, and phenylalanine, destruction accounted for practically all of the inactivation. The important point is that, except for cystine which is very insoluble under the conditions of autoclaving, over 45% of each of the free amino acids was destroyed when autoclaved with a mixture of soybean protein and sucrose.

From the results of this investigation it appears that at least three types of reaction are involved in the inactivation of amino acids by prolonged autoclaving of a sucrose containing food or feed, such as soybean oil meal. Lysine, aspartic, and glutamic acids combine with some constituents of the protein, probably the free carboxyl with the free amino groups, to form enzyme-resistant linkages. The amino acids with free amino groups react with sucrose to destroy the amino acids. Protein-bound methionine, cystine, and histidine with sucrose form linkages resistant to enzymatic hydrolysis *in vitro*.

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Improved Apparatus for Radiobiological Syntheses[1]

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Radioactive natural compounds, invaluable tracers for studying intermediary metabolism, are most conveniently prepared by radiobiological methods. Livingston and Medes (*4*) demonstrated that a detached leaf can efficiently photosynthesize $C^{13}O_2$ into C^{13} carbohydrates. Aronoff, Benson, Hassid, and Calvin (*1*) first reported a preparation of radioactive C^{14} glucose; and Putnam, Hassid, Krotkov, and Barker (*6*) have given detailed instructions for preparation. However, the apparatus designs employed by these pioneer workers warrant considerable improvement. A simplified photosynthesis apparatus and procedure, used to prepare C^{14} glucose for poliomyelitis studies, is described in this paper.

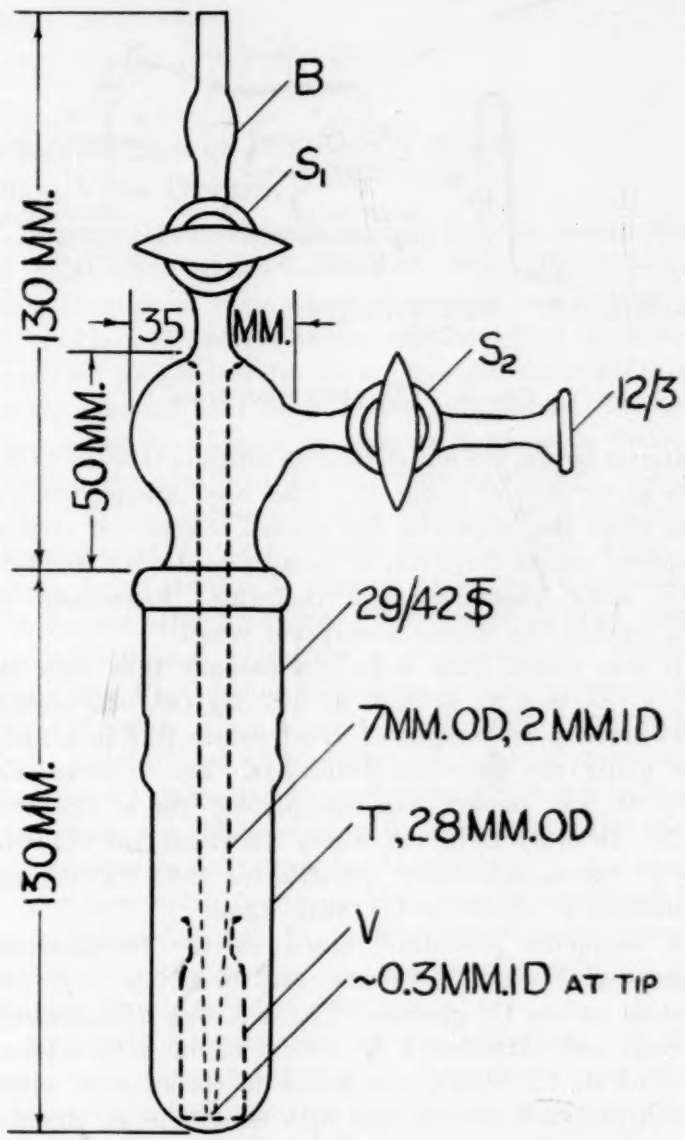

Fig. 1. Photosynthesis vessel.

Tube (T) (Fig. 1) is rinsed with water and left moist. A mature sweet potato leaf (petiole detached, fresh weight about 350 mg), which was removed from a plant in the light about 18 hr earlier, wet thoroughly, wrapped in wax paper and stored in the dark, is now arranged (under side facing in) about the inner surface of the tube. A 6-ml vial (V), containing 50 mg of $BaC^{14}O_3$, moistened to avoid possible scattering, is placed at the bottom of the tube; the standard taper joint lubricated; and the photosynthesis vessel assembled as shown. The vessel is evacuated through stopcock (S_2), 0.5 ml of 3N $HClO_4$ is introduced into bulb (B) by means of a narrow-tipped dropper, and stopcock (S_1) is carefully opened to admit the acid to the carbonate. When the

[1] This work was aided by a grant from the National Foundation for Infantile Paralysis.

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acid solution is clear and no longer effervescent, carbon dioxide-free air is admitted through stopcock (S_1) to restore the internal pressure to atmospheric. Finally, the vessel is slipped into a stiff wire holder so adjusted that the vessel is disposed parallel to and 5 cm from a 40-watt fluorescent lamp. The above manipulations can be carried through in 7 min or less.

After photosynthesis has continued for 24 hr, 2 CO_2 absorption vessels, each containing 10 ml of 0.05N $Ba(OH)_2$ solution, 5% in $BaCl_2 \cdot 5H_2O$, are attached as shown in Fig. 2. The second vessel connects with a

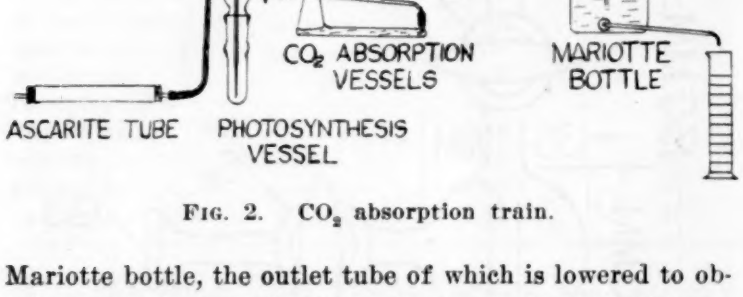

FIG. 2. CO_2 absorption train.

Mariotte bottle, the outlet tube of which is lowered to obtain an air flow of about 10 ml per min through the system when the stopcocks are opened. After 20 min of aeration, excess $Ba(OH)_2$ is back-titrated with standard HCl, using phenolphthalein indicator. Essentially no CO_2 reaches the second absorption vessel.

It was found from seven preliminary runs with inactive CO_2 that an average of 0.27 mg CO_2 was assimilated per mg dry weight of sweet potato leaf in a 24-hr run under the described conditions. For a 10-hr run, 52% of this amount was assimilated; for a 2-hr run, 12%. In every 24-hr run where the amount of CO_2 was not in excess, essentially quantitative (98.8–99.6%) assimilation of available CO_2 took place.

A simplified procedure, based on the fractionation scheme of Hassid, McCready, and Rosenfels (*3*), was used to isolate C^{14} glucose. The leaf was homogenized, filtered, and extracted 1 hr with 5 ml of 80% alcohol. Five ml of 1N H_2SO_4 was added to the extract, which was hydrolyzed for 30 min with simultaneous elimination of the alcohol by distillation. A small excess of hot 10N $Ba(OH)_2$ was added, the suspension slightly re-acidified with H_2SO_4 and brought to final neutrality with solid $BaCO_3$. After centrifuging off the residue and adding 300 mg of carrier glucose, the sugar solution was concentrated under vacuum to a syrup, taken up in 10 ml of 95% alcohol, brought to turbidity with ether, and set aside for glucose crystallization.

The extracted leaf residue was boiled 15 min with 5 ml of acid alcohol (4 ml of concentrated H_2SO_4 stirred into 500 ml of 95% alcohol), and extracted 15 min. The residue was then boiled 1 hr with 5 ml of water and water extracted 15 min. The combined aqueous starch solutions were then treated in exactly the same manner as described for the 80% alcohol extract, except that acid hydrolysis was continued for 1 hr, and only 100 mg of carrier glucose were needed to assure satisfactory crystallization.

There were obtained from the starch extract 69 mg of crystalline glucose, 0.25 μc/mg, and from the soluble sugar extract 189 mg, 0.027 μc/mg.[a] Of the total activity assimilated, 26% was accounted for in the starch and soluble sugar extracts, 11% in the $BaSO_4$ residue from the alcohol extract, and 32% in the residual leaf material.

The sweet potato was used because of the ease of maintaining a continuous leaf supply for preliminary work. For the specific purpose of glucose preparation, other leaves are apparently superior. Whereas the potato leaf fixed 26% of the assimilated activity as starch and soluble sugar, Aronoff *et al.* (using the barley seedling) report 25 to 35%, Putnam *et al.* (using the tobacco leaf) apparently report 45 to 55%, and Livingston and Medes (using the bean leaf) claim 90% fixation.

Significant improvements will now be summarized: (1) A compact and simplified photosynthesis vessel permits considerable economy of time and effort in manipulation. (2) No special devices or leaf pretreatment are necessary to preserve humidity or the water content of the leaf, as evidenced by the fresh turgid condition of the leaf after a 24-hr photosynthesis period and by the essentially quantitative assimilation of a substantial amount of CO_2 during this period. (3) No special temperature control apparatus is necessary, despite the proximity of light source and leaf. (4) The evolution of CO_2 within the vessel is rapid yet under positive control, eliminating the spattering hazard.

Perhaps the greatest advantage is the adaptability of the apparatus to subsequent fractionation procedures. For example, the leaf may be directly homogenized in the photosynthesis tube by the insertion of a rotating pestle, after the manner of Potter and Elvehjem (*5*). Centrifugation or, with the use of the universal micro-apparatus to be described elsewhere (*3*), filtration and extraction procedures are possible without transfer of the plant material. Any such minimization of transfer is highly desirable when dealing with small amounts of material, especially radioactive material.

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[a] These are approximate values as based on the stated activity of a $BaC^{14}O_3$ shipment from Oakridge.

Comments and Communications

Animal Experimentation in the District of Columbia

On September 15, 1948, the executive committee of the AAAS adopted unanimously a resolution reaffirming its support for animal experimentation, in the interests of man and other species, and stating its belief that animals for research and teaching should be provided by legislation or ordinance where necessary. Such legislation has been adopted in Michigan and Minnesota, and ordinances of the type supported are in effect in Chicago, Dallas, and many other cities. Similar proposals have been defeated in Pennsylvania and deferred in Maryland, Massachusetts, and elsewhere. The campaign nationally, under the auspices of the National Society for Medical Research, for positive legislation of this sort, is at a stage of rather precarious dynamic equilibrium.

In April bills were introduced in Congress to provide a fraction of the unclaimed impounded animals in the District of Columbia for teaching and research in local institutions inspected and licensed by the Health Department. At present, such animals are slaughtered. Because Congressional action is called for, a good deal of national interest has been aroused, although the bills are District of Columbia measures. The antivivisectionists, at least, realize the wider significance of the measures, and have organized a national telegram-and-letter campaign which, together with display advertising in local newspapers, has resulted in a flood of communications to Congressmen and the District of Columbia Commissioners. Since Senate hearings have ended, it is especially important that letters and telegrams of support be sent the District of Columbia Committees of House and Senate. The AV's have thousands of dollars in their local treasuries for this campaign.

The Committee for Health and Research, composed of local teachers, physicians, scientists and other friends of progress in medicine and related fields, have *no* funds and, since the Committee was organized only recently, few members. We cannot match, therefore, such efforts as the opposition's national mailing to members and friends of the American Humane Association. Through the columns of *Science*, however, we hope to galvanize the silent majority (amounting, according to sampling of the public, to more than 90% of the American people) on our side.

The Committee ask that readers of *Science* (1) write letters or send telegrams to the District of Columbia Commission and to the District of Columbia Committees of House and Senate, supporting H.R. 4349 and S. 1703; and (2) secure similar action by organizations of all types—parent-teacher associations, citizens' groups, unions, faculties of educational institutions, and professional, scientific and industrial bodies—of which readers are members.

The Committee will be glad to furnish copies of the bills and other information upon request. The fate of H.R. 4349 and S. 1703 will affect the supply of animals for teaching, research and consumer testing in every community in the United States. Quick support is essential.

WILLIAM F. HEWITT, JR.
Executive Secretary,
Committee for Health and Research

Interpretation of Lindner's Test for Plant Virus Diseases

In using Lindner's colorimetric test for the presence of plant virus diseases (*Science*, 1948, 107, 17) in a tissue culture of virus tumor discovered and isolated by L. M. Black in 1944, it became apparent that the method described by Lindner for virus presence is a modification of the Benedict test for reducing substances. The components of the reagent are similar to those in Benedict solution—an alkaline solution of copper sulfate. Lindner says, "Copper sulfate seems to catalyze the formation of the red color." Actually the copper sulfate is the reagent, being reduced to cuprous oxide, hence accounting for the red color produced. The blue-green color resulting when normal, virus-free leaves were tested probably came from the reducing substances normally present; and the red color, when virus-infected leaves were tested, from an abnormal accumulation of reducing substances. In Cook's *Viruses and virus diseases of plants*, there are conflicting reports concerning the accumulation of reducing substances in virus-infected plants.

The interfering factor, girdling, can be accounted for, since it is well known that the procedure causes accumulation of carbohydrates and apparently reducing substances above the ringed portion.

Lindner's interpretation of the test—that the virus may cause some disturbance in the phloem—can be extended to include the idea that it also causes accumulation of reducing substances.

The following materials were tested for the presence of virus disease, according to the method outlined by Lindner:

MATERIAL	AMOUNT OF RED COLOR PRODUCED (CUPROUS OXIDE FORMED)
Glucose	+++
Virus tumor	+++
Agar on which tumor was grown	++
Virus-free pea leaves	+

This communication does not decry the usefulness of the test as a detector of virus diseases, but urges that

when it is used, the results be interpreted in terms of reducing substances present.

SALLY KELLY

Department of Plant Science,
Vassar College

Note on the Chemistry of Dramamine

In the treatment of various allergies by the antihistaminic drugs which have appeared so profusely in the last few years, there have been observed undesirable side reactions, such as drowsiness, which detract from their usefulness. Attempts have been made with certain of the antihistamines to offset the drowsiness by chemical combination with the methyl xanthines, selected because of their central nervous stimulating properties. Because of the low ionization constants of the methyl xanthines, however, no stable salts were obtained.

The chemical problem has been solved in the case of β-dimethylaminoethyl benzohydryl ether (Dramamine) by the use of 8-chlorotheophyllin, which has a high enough ionization constant to form a stable salt.

The salt is readily made by dissolving the 8-chlorotheophyllin with a slight excess of the base in any suitable hot organic solvent, such as methyl ethyl ketone or ethanol. On cooling, it precipitates as a nice sandy material in almost quantitative yield based on 8-chlorotheophyllin, mp 101–3° C, empirical formula $C_{24}H_{30}O_3N_8Cl$.

Analysis:	Theory %	Found %		
Chlorine	7.55	7.45	7.46	7.51
Basic N	2.98	2.98	2.98	
8-Chlorotheophyllin	45.67	45.65	45.62	

The use of this compound in preventing motion sickness was reported by Leslie N. Gay and Paul E. Carliner at the meeting of the Johns Hopkins Medical Society, February 14, 1949, and a statement was published in *Science*, April 8, 1949.

JOHN W. CUSIC

G. D. Searle and Company, Chicago

Association Affairs

K. Lark-Horovitz, head of the Department of Physics and director of the Physical Laboratory at Purdue University, has been elected general secretary of the AAAS for the term ending 1952. His election follows a brief period of service to complete the unexpired term of the late Otis W. Caldwell.

Dr. Lark-Horovitz is best known for his researches in the physics of solid state and nucleonics and for his recent experimental investigations and theoretical interpretations of the behavior of electronic semiconductors. He is chairman of the Cooperative Committee on the Teaching of Science for the association and was one of the contributors to Vol. IV of the President's Scientific Research Board Report.

The new secretary will also serve on the Publications Committee.

Affiliated and Associated Societies[1] Meeting with the AAAS New York, December 26–31

Nearly all of the affiliated and associated societies meeting with the American Association for the Advancement of Science at its 116th Annual Meeting in New York City, December 26–31, 1949, have reported the preliminary estimates of their session room requirements. The following list of individual meetings is compiled from the reports of the secretaries of these societies and sections. (The exact dates of each within the six-day period are tentative in only a few instances.)

AAAS.—Presidential Session and Reception of AAAS, evening of Dec. 28; Symposia sponsored by AAAS, afternoon of Dec. 29. (Association headquarters hotel, Statler.)

A—Mathematics.—American Mathematical Society, Dec. 27–29; Institute of Mathematical Statistics;[2] Mathematical Association of America, Dec. 29, 30. (Mathematicians Headquarters hotel, Governor Clinton.)

B—Physics.—Section B, Dec. 29, 30.

C—Chemistry.—Section C, Dec. 29–31. Phi Lambda Upsilon.

D—Astronomy.—Section D.

E—Geology and Geography.—Section E and Geological Society of America, joint meeting; American Geographical Society of New York; Association of American Geographers; National Geographic Society, Annual Lecture, afternoon of Dec. 27.

F—Zoological Sciences.—Section F; American Society of Parasitologists, Dec. 27–29 (including demonstrations at Columbia); American Society of Zoologists, Dec. 28–30; Society of Systematic Zoology, Dec. 29. Zoologists' headquarters hotel, Statler.)

FG—Zoological and Botanical Sciences.—American Microscopical Society, Dec. 27 and 30; American Society of Limnology and Oceanography, Dec. 28–30; American Society of Naturalists, Dec. 30 (Biologists' smoker probably Dec. 29); Beta Beta Beta Biological Fraternity, Dec. 28; Biometric Society, Eastern North American Region; Ecological Society of America, Dec. 27–29; Genetics Society of America, Dec. 28–30 (including demonstrations at Columbia); American Society of Human Genetics; National Association of Biology Teachers, Dec. 27–30; Society for the Study of Evolution, Dec. 27–30, a panel discussion of "Botany in the Service of Mankind."

[1] Notices of the dates and places of the meetings of affiliated and associated societies, *not* meeting with the AAAS, appear in *Science* and *The Scientific Monthly* whenever that information is sent in directly to the editorial offices.

[2] These societies also are participating in the programs of the Allied Social Science Association organizations which are meeting at the same time in the Grand Central Zone of New York City.

G—Botanical Sciences.—Section G, Dec. 29; American Phytopathological Society, Dec. 27–30; American Society of Plant Physiologists, Dec. 27–29; American Society of Plant Taxonomists, Dec. 27–30; Botanical Society of America, Dec. 26–30; Mycological Society of America, Dec. 27–30; Torrey Botanical Club; American Fern Society; American Bryological Society, Dec. 27–28; Phycological Society of America, Dec. 27–28. (Plant sciences headquarters hotels, McAlpin and adjacent Martinique.)

I—Psychology.—Section I, Dec. 27–28 (including joint meeting with Section Q); Society for Research in Child Development, Dec. 28–29.

K—Social and Economic Sciences.—Section K; Academy of World Economics and American Economic Association,[2] joint meeting, Dec. 28; American Sociological Society, Dec. 27–29; American Statistical Association;[2] Econometric Society;[2] Pi Gamma Mu; Metric Association, Dec. 30.

L—History and Philosophy of Science.—Section L and Philosophy of Science Association, joint meeting, Dec. 29–30.

M—Engineering.—Joint meetings of Section M and Instrument Society of America, Dec. 26; Technical Society Council of New York, Dec. 27; Metropolitan Section of American Society of Mechanical Engineers, Dec. 30.

N—Medical Societies.—Section N; Subsection Np, Pharmacy, Dec. 27, 28; Alpha Epsilon Delta Premedical Honor Society, Dec. 27; American Dietetic Association.

Q—Education.—Section Q, Dec. 27, 28 (including joint meeting with Section I); National Science Teachers Association, Dec. 27–30. Science Teaching Societies affiliated with the AAAS, i.e., ANSS, NABT, NSTA and the Cooperative Committee of the AAAS, will hold joint meetings Dec. 27–29; (Science Teaching, Education and Psychology headquarters hotel, New Yorker).

X—General Science Societies.—American Nature Study Society, Dec. 27–30 (including an all-day Field Trip, the last day); Honor Society of Phi Kappa Phi, Dec. 28, 29; National Association of Science Writers; Sigma Delta Epsilon, Graduate Women's Scientific Fraternity, Dec. 28, 29; The Society of the Sigma Xi, Dec. 27 including the annual address in the evening.

Nearly all the Association's 17 Sections and Subsections are planning strong programs (synopses of the Section programs will appear in *Science* shortly). A special committee of the Executive Committee of the American Association for the Advancement of Science is arranging for the symposia in the fields of biology and physical sciences. There are numerous joint meetings and several symposia planned by the societies themselves—including one on experimental cell research, and the coordinated program of the science teaching societies in conjunction with the AAAS Cooperative Committee.

It is already apparent that the 1949 Annual Meeting will be one of the best balanced and most convenient in the Association's 101-year history. It has been possible, for instance, to concentrate the zoological and medical meetings in the Statler and nearby Governor Clinton, the educational, science-teaching and psychological meetings in the New Yorker, and all of the plant sciences in the McAlpin and adjacent Martinique. A few societies such as the mathematical groups and the Ecological Society of America, that particularly desire academic classrooms, will be accommodated in Columbia University (20 minutes away from the Penn Zone on the Broadway-Seventh Avenue or West Side subway).

Firms and other organizations of service to science have recognized that this will be one of the best attended meetings. At this time, seven months in advance, the following already have made definite arrangements to exhibit in the Penn Top of the Hotel Statler: The Albino Farms; American Book Company; American Cancer Society; American Optical Company; Appleton-Century-Crofts, Inc.; The Association of American University Presses; Bausch and Lomb Optical Company; Biological Abstracts; The Blakiston Company; Bussey Products Company; Cambridge Instrument Company, Inc.; Carolina Biological Supply Company; Fred S. Carver, Inc.; Central Scientific Company; Cinchona Products Institute, Inc.; Coreco Research Corporation; Thomas Y. Crowell Company; Denoyer-Geppert Company; International Business Machines Corporation; Eastman Kodak Company; Gamma Scientific Company; General Biological Supply House, Inc.; Harper and Brothers; Jarrell-Ash Company; Kahl Scientific Instrument Corporation; E. Leitz, Inc.; The Linguaphone Institute; J. B. Lippincott Company; The Macmillan Company; McGraw-Hill Book Company, Inc.; G. & C. Merriam Company; The C. V. Mosby Company; National Geographic Society; National Spectrographic Laboratories, Inc.; New York Scientific Supply Company, Inc.; Nuclear Instrument and Chemical Corporation; The Nucleonic Corporation of America; Pfaltz and Bauer, Inc.; Philosophical Library; Prentice-Hall, Inc.; The Rayoscope; Rinehart and Company, Inc. and Murray Hill Books, Inc.; W. B. Saunders Company; Schwarz Laboratories, Inc.; The Squibb Institute for Medical Research; The Technicon Company; Tracerlab, Inc.; Ward's Natural Science Establishment, Inc.; W. M. Welch Scientific Company; and John Wiley and Sons, Inc.

Advance registration and hotel room reservation will begin in September. There will be coupons in *Science* for both. The New York Convention Bureau will handle the reservations and the hotels will send prompt confirmations directly.

The Advisory Board of the Gordon Research Conferences has elected Charles N. Frey, director of Scientific Relations of Standard Brands, Inc., and Herman Mark, director of the Institute of Polymer Research and professor of organic chemistry, Polytechnic Institute of Brooklyn, to the Management Committee of the conferences. The Executive Committee of the AAAS has confirmed the election. Dr. Frey and Professor Mark succeed Dean Burk, National Institutes of Health, and George Calingaert, director of chemical research at the Ethyl Corporation, who will retire next September.

NEWS and Notes

National Science Foundation. The Subcommittee on Public Health, Science, and Commerce of the House of Representatives' Committee on Interstate and Foreign Commerce, has completed its consideration of science foundation bills. On May 24 the chairman, J. Percy Priest, introduced a new bill, H. R. 4846, which embodies the subcommittee's compromises and revisions of the several bills it has had under consideration.

H. R. 4846 differs in details from the earlier bills. The responsibilities of the 24-man board and of the director are more clearly defined than in earlier bills. Like most of the earlier ones, but unlike S. 247 (the bill passed by the Senate), H. R. 4846 requires the selection of an executive committee of the board. The medical commissions are optional rather than required in both Senate and House bills. Throughout H. R. 4846 there are a number of changes in wording and rearrangements of sections. These changes clarify the Foundation's operations without altering its functions.

The bill must next receive approval of the Committee on Interstate and Foreign Commerce. The earliest possible date for that approval is June 6. Then it will be ready for scheduling for a vote by the House of Representatives. All scientists who are interested in the establishment of a National Science Foundation should immediately inform their Representatives that they want H. R. 4846 passed promptly.

DAEL WOLFLE

David T. Smith, bacteriologist at Duke University, has been named president-elect of the National Tuberculosis Association to succeed **R. D. Thompson** of Pasadena, California. Dr. Smith was recently awarded a $4,000 renewal grant by the association to continue his studies of chemical agents that appear to inhibit growth of tuberculosis germs.

Richard H. Young, dean of the College of Medicine, University of Utah, has been appointed dean of Northwestern University School of Medicine. Dr. Young will succeed **J. Roscoe Miller,** who will become Northwestern's president in July.

Giles E. Hopkins, former director of applied research of the Textile Research Institute, has been appointed technical director of the Wool Bureau, Inc. He will direct a continuing study of the chemical and physical characteristics of wool.

Jacob Furth, director of the Branch Reference Laboratory, Veterans Administration Hospital at Dallas, Texas, has been appointed chief of the pathology section, Division of Biology, Oak Ridge National Laboratory.

Midwest Research Institute of Kansas City, Missouri, has announced the appointment of **Max H. Thornton** as chairman of its Chemical Research Division.

Percy Williams Bridgman, research professor of physics at Harvard University, and **Norman Levi Bowen,** petrologist in the geophysical laboratory of Carnegie Institution in Washington, have been elected to the Royal Society of Great Britain.

Paul E. Hemke, head of the Department of Aeronautical Engineering, Rensselaer Polytechnic Institute, has been appointed faculty dean of the institute. He will succeed **Matthew A. Hunter,** who is retiring at the end of the college year.

Visitors to U. S.

W. Flügge, French mechanical engineer, is teaching a course based on his book *Statics and dynamics of shells* at the Stanford School of Engineering. Dr. Flügge's wife, **Irmgard Flügge-Lotz,** is also lecturing at the school during the spring quarter on "Theory of Boundary Layer."

Visitors at the National Bureau of Standards during the week of May 16–20 included: **T. Bedford,** chief chemist, Bureau of Standards, Pretoria, South Africa; **Lars Melander,** radiochemist, Nobel Institute for Physics, Stockholm; **Marcel J. Pourbaix,** chef de travaux, University of Brussels; **Dag Hartman,** chief radio and electronics engineer, Saab Aircraft Company, Linkoping, Sweden; **A. Masson** and **A. Sable** Société d'Electrochimie d'Ugine, Paris; **William Wild,** Ministry of Supply, Atomic Energy Research Establishment, Harwell, England.

Dominic Brachett, director of the Cancer Institute of the University of Buenos Aires, is visiting the University of Texas Medical Branch, Galveston, to work with W. W. Nowinski, director of the Neuro-Chemistry Laboratory, on enzyme factors in tissue growth.

Grants and Awards

The Passano Foundation of the Williams and Wilkins Company will present its annual $5,000 award for the advancement of medical research to Oswald T. Avery, member emeritus of the Rockefeller Institute for Medical Research. The presentation will be made on June 8. Dr. Avery, the fifth recipient of the award, will be honored for his classification, analysis, and investigation of the immunological relationships of the pneumococci.

The University of Chicago presented the first **Howard Taylor Ricketts Award** for outstanding service to medicine on May 3, the anniversary of the death of Dr. Ricketts. The medals were awarded to Ludvig Hektoen, who has been chairman of the Department of Pathology at the university and director of the McCormick Institute for Infectious Diseases, and to Russell Wilder, head of the Division of Medicine at the Mayo Clinic.

Summer Programs

The Second Canadian Mathematical Congress and Seminar will be held at the University of British Columbia, Vancouver this summer, the seminar August 16–September 10 and the congress September 5–10. Members of the American Mathematical Association are invited to attend. Further information may be obtained from the Canadian Mathematical Congress, Engineering

uilding, McGill University, Montreal, Canada.

North Dakota Agricultural College will conduct a paint short course une 27–July 10. The course will ress recent developments in the chnology of paint and will be administered by the university's chool of Chemical Technology.

Meetings and Elections

The New Orleans Academy of Sciences, at its annual meeting at Tulane University, New Orleans on April 29–30, elected the following officers: president, L. J. Strohmeyer, Loyola University; vice president, F. R. Cagle, Tulane University; secretary, W. G. Moore, Loyola University; treasurer, J. K. Reiss, Tulane University; curator, G. F. Taylor, Tulane University; members of executive council, T. L. Duggan, Loyola University and R. Campbell, U. S. Forest Service.

The United States was doubly honored at the recent meetings of the **International Geographical Congress** held at Lisbon, April 8–15. The general assembly voted to hold the next congress, the seventh, in the U. S. in 1952, thus recognizing the centenary of the American Geographical Society, and elected as its new president George B. Cressey, chairman of the Department of Geography at Syracuse University. The congress brought together 330 geographers from some 30 countries; registration from organizations and individuals not in attendance brought the total to 706. Unfortunately, no delegates were present from behind "the iron curtain." In order to stress the international character of the union, the nine newly elected officers were chosen from nine countries, with representatives from both Asia and Latin America. The new secretary is George T. K. Kimble, of McGill University in Montreal.

The private and professional character of the International Geographical Union was reaffirmed, although in a number of countries the dues are paid by the government. Membership is through a series of national committees, each appointed by the principal academy of science or national research council which serves as the adhering organization. The union changed its statutes to provide for a new voluntary basis of membership in which each country elects to join one of eight categories with a graduated series of 1 to 15 units for the dues. Until the time of the next congress each unit has been fixed at $100. The former basis of graduated voting was abolished so that in administrative matters each national committee has an equal vote.

The principal activities of the union between sessions of the congress concern the operation of a series of commissions, 13 of which were appointed at Lisbon. These range from problems in population, ports, land use, and medical geography to periglacial morphology, soil erosion, terraces, and aerial photo interpretation.

GEORGE B. CRESSEY

The American Society for Pharmacology and Experimental Therapeutics, at its Detroit meeting, April 18–22, elected the following officers: president, Carl F. Schmidt, University of Pennsylvania; vice president, John C. Krantz, Jr., University of Maryland; secretary, Harvey B. Haag, Medical College of Virginia; treasurer, K. K. Chen, the Lilly Research Laboratories; and councilors, Thomas C. Butler, Johns Hopkins University; Arthur C. DeGraff, New York University; and Robert A. Woodbury, University of Tennessee.

The Society for General Microbiology held a symposium on "The Nature of the Bacterial Surface" at the Royal Institution in London on April 20-21. The principal speakers were N. W. Pirie, Rothamstead Experimental Station; W. T. J. Morgan, the Lister Institute for Preventive Medicine; M. Stacey, Birmingham University; Peter Mitchell, Biochemical Laboratory, Cambridge; T. F. Anderson, University of Pennsylvania; A. A. Miles, National Institute for Medical Research; E. T. C. Spooner, London School of Hygiene and Tropical Medicine; Harriet E. Taylor, Laboratoire de Genetique, Paris; A. Pijper, Pretoria University; T. Y. Kingma Boltjes, of Amsterdam; W. van Iterson and A. L. Houwink, both of Delft; D. McLean, of Elstree; Sir Alexander Fleming and W. H. Hughes, both of Paddington.

At the annual general meeting of the society the following officers were elected: president, J. W. McLeod; honorary treasurer, H. J. Bunker; and honorary secretaries, J. G. Davis (general) and W. E. van Heyningen (meetings).

The Association of Southeastern Biologists elected the following officers at its annual meeting, April 14–16, at the University of Tennessee: president, Howard M. Phillips, Emory University; president-elect, Elon E. Byrd, University of Georgia; vice president, Harley B. Sherman, University of Florida; secretary-treasurer, Alvin V. Beatty, Emory University; members of the executive committee, Bruce D. Reynolds, University of Virginia and Dalton M. Brown, East Tennessee State Teachers College. Dr. Phillips was appointed the association's representative on the Council of the AAAS.

The 23rd National Colloid Symposium, sponsored by the Colloid Division of the American Chemical Society, will be held at the University of Minnesota June 6–8. The meeting will be devoted to discussion of five phases of colloid chemistry: proteins, inorganic colloids, membranes, carbon blacks and solubilization, and ion exchange phenomena.

The National Research Council and the Office of Naval Research will jointly sponsor a **Symposium on Wood** which will be held June 16–17 at the National Academy of Sciences. One session of the meeting will be devoted to the requirements of the National Military Establishment; other sessions will cover mechanical, chemical, and biological aspects of wood; a fifth session will discuss marine borers.

The Division of Physical and Inorganic Chemistry of the American Chemical Society will hold a **Symposium on the Solid State** at the Mellon Institute in Pittsburgh June 20–22. William J. Kirkpatrick

will be chairman of the meeting, and E. L. Warrick is in charge of housing. Both may be addressed in care of the Mellon Institute.

A Symposium on Light and Living Organisms will be held at the annual meeting of the Society of General Physiologists at the Marine Biological Laboratory in Woods Hole, Massachusetts June 22–24. Further information may be obtained from Professor Arthur K. Parpart, Biology Department, Princeton University.

Meetings and Elections

The New England Section of the Optical Society of America was installed May 5, in Boston. Stanley S. Ballard, secretary for Local Sections, officiated at the installation, and was assisted by two former OSA presidents, Arthur C. Hardy and George R. Harrison. The speech of the evening, "Color Translation and Ultraviolet Microscopy," was given by Edwin H. Land.

The new section, formerly the New England Optical Society, draws its membership largely from the greater Boston area, but meetings are also attended by scientists and students from Rhode Island, Connecticut, New Hampshire, and western Massachusetts.

The newly elected officers are: president, Duncan E. Macdonald, Boston University Optical Research Laboratory; vice president, David S. Grey, Polaroid Corporation; secretary, John T. Watson, Boston University Optical Research Laboratory; and treasurer, Russel P. Mahan, Baird Associates, Inc.

Deaths

Harry T. Edwards, 71, fiber specialist, died May 6 in Washington, D. C. Dr. Edwards, who retired from the Department of Agriculture in 1945 after 28 years of service, was instrumental in introducing manila hemp plantations into tropical America in 1925.

Philip Sidney Smith, 71, geologist, died May 10 at St. Albans, Vermont. Dr. Smith joined the Geological Survey in 1906, and retired as chief of the Alaskan Division in 1946.

John M. Cooper, 69, chairman of the Department of Anthropology at Catholic University, died May 4 of a heart attack at the university. Msgr. Cooper, author of several volumes on North American Indian tribes, was editor of the scientific magazine, *Primitive Man,* and publications of the Catholic Anthropological Conference; the prelate also served on the editorial boards of the *Journal of Social Hygiene* and *Parents' Magazine.*

William W. Hansen, 39, physicist, died May 23 in Palo Alto, California. Dr. Hansen, pioneer in radar research and development, was elected to the National Academy of Sciences and was awarded the Liebman Memorial prize for outstanding work as a radio engineer.

Starring will be temporarily discontinued for the eighth edition of *American Men of Science.* It has been announced by Jaques Cattell, editor, that the growth and integration of all fields of science since the publication of the last edition have made the establishment of an equitable system of starring very difficult. After consultation with the special Committee on Starring appointed by the AAAS, he has decided to leave open the question of starring in future editions of the directory.

A Guide to Russian Scientific Periodical Literature, published by the Brookhaven National Laboratory for the purpose of acquainting English-speaking scientists with the work of the Soviet Union, may be obtained by writing to the Information and Publications Division Brookhaven National Laboratory, Upton, New York. The seven issues published to date include translations of titles of articles in Russian scientific journals, beginning with 1947 when the Russians discontinued the printing of English text in their journals; translated abstracts of papers on physics and nuclear science; complete translation of significant articles in the field of nuclear science, such as the one on cosmic rays by A. I. Alikhanyan; and listings of titles of translated articles available at Brookhaven's Central Repository for Translations of Russian Scientific Articles.

Ruins of stone-and-whalebone houses built by ancient Thule Eskimos on Cornwallis Island in the northern Canadian Arctic Archipelago will be explored this summer. Henry B. Collins, Jr., and J. P. Michea will represent respectively the sponsors of the expedition, the Smithsonian Institution and the National Museum of Canada. The archeologists hope by their excavations at Resolute Bay to establish the relationship between the 500-to-800-year-old Thule culture and that of the Dorset Eskimos, predecessors of the Thules. The village sites may also reveal information about the migration of both groups eastward and northward to Greenland.

Make Plans for—

Symposium on Fine Particles and Resolutions, June 9–10, Stevens Hotel, Chicago.

American Physical Society, semicentennial meeting, June 16–18, Cambridge, Massachusetts.

Institute of Mathematical Statistics, June 16–18, Berkeley, California.

American Society of Medical Technologists, annual convention, June 19–23, Hotel Roanoke, Roanoke, Virginia.

Mathematical Association of America, joint meeting with **Mathematics Division, American Society for Engineering Education,** June 20–21, Rensselaer Polytechnic Institute, Troy, New York.

American Institute of Electrical Engineers, summer general meeting, June 20–24, New Ocean House, Swampscott, Massachusetts.

Heat Transfer and Fluid Mechanics Institute, June 22–24, University of California, Berkeley.